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Centrifugal Fans and Rotary Blowers

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Centrifugal Fans and Rotary Blowers

...BY...

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THESIS

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May 31, 1900.

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Charles Sunderland Johnson

ENTITLED Centrifugal Fans and Rotary Blowers

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science in Mechanical Engineering.

L. P. Breckenridge

HEAD OF DEPARTMENT OF Mechanical Engineering.

CENTRIFUGAL FANS & ROTARY BLOWERS.

For the movement of large volumes of air there are five general types of machines. These are the disk or propeller fan, the centrifugal fan, the rotary blower, the piston blower and the steam jet blower.

Each of these machines seems to have its own field of adaptability to which it is best suited and in which it should always be used if efficient service is desired. The disk or propeller fan is best suited for moving almost any volume of air when practically no resistance is offered to its flow. When a resistance corresponding to from three fourths of an ounce to sixteen ounces per square inch is found then the centrifugal fan is used. The rotary blower is probably best adapted for handling air at from one to five pounds per square inch. If the pressure is higher than this then the piston blower comes into use. The steam-jet finds a field of its own not on account of any mechanical efficiency but because of its simplicity and great adaptability in producing the draft in locomotives and other boilers. In its use the moisture which comes from the steam plays an important part in breaking up the clinkers that are formed on the grates. This makes the steam-jet very useful when hard coal is used.

The above machines may be classified according to their form and construction or according to their use.

A classification as to construction:

Fans.	(Disk Fan.) ( ) (Centrifugal Fan.
Positive Blowers.	(Piston Blower.) ( ) (Rotary Blower.
Steam-jet.	

A classification as to use:

Exhausters.	(Disk Fan.) (Centrifugal Fan.) (Steam-jet.
Blowers.	(Piston Blowers.) (Rotary Blowers.) (Centrifugal Fan or Blower.

These classifications serve to show the relation between the centrifugal fan, rotary blower and other air propelling machines.

Constructive features of rotary blowers.

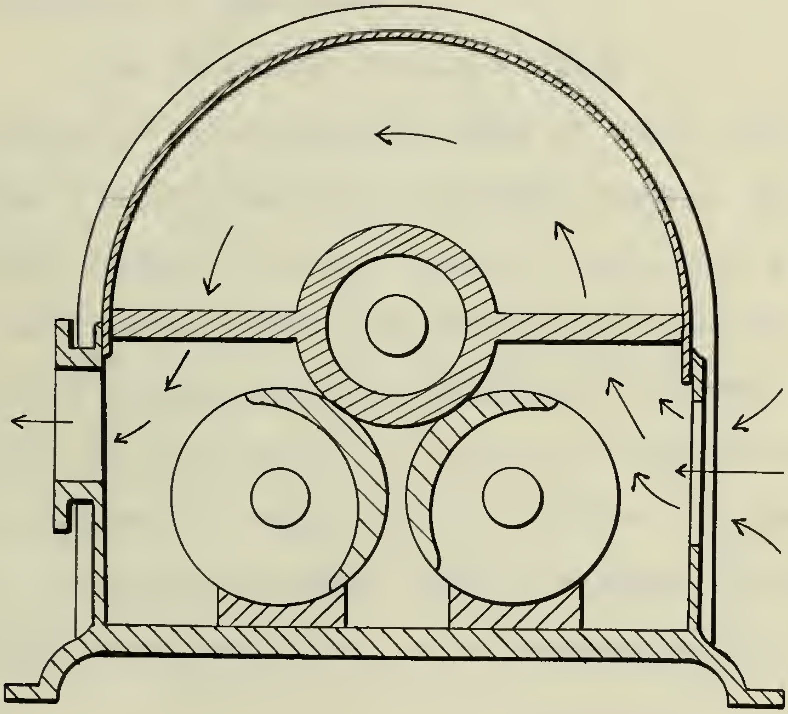
There are a number of makes of rotary blowers on the market and it is interesting to study the different mechanisms that have been devised to accomplish the same results. Each of these has its own features. They all depend, however, upon the one working principle that the air is confined between two surfaces, stationary or movable, compressed by a reduction of volume and then ~~alle~~ allowed to escape at the pressure thus obtained. It is from this principle that the name "positive blower" is probably derived.

This priciple is apparently perfect and would undoubtedly yield good results if friction and leakage could be eliminated. But these difficulties are so marked that they greatly reduce the mechanical efficiency. Another objection found is the frequent necessity for a renewal of working parts.

The Baker Rotary Blower.

The external case of this blower is made of boiler iron, turned up truly and inserted into the heads of the machine. The heads are made of cast iron and are securely bolted to the bed plate. These heads are bolted together longitudinally by iron rods on the outside of the case. The drum concentric with the case as well as the two lower drums are solid castings and are turned as true as possible. The lower drums act as abutments for the blades. The motion of the air is as indicated on the drawings. Gearing on the exterior of the case serves to turn the drums and keep them in their proper relative positions. The lower drums are revolved in opposite direction from the upper drum. A wire guard or screen is placed over the inlet to prevent anything from entering that might injure the working of the blower. The driving pulley is keyed to the shaft of the upper drum.

This blower offers considerable chance for slip or leakage back into the inlet chamber. Besides the air which can get by the drums and blades the space between the two lower drums is filled every revolution with air from the discharge side and this is then allowed to escape into the inlet chamber.



Baker Blower.

The Mackenzie Blower.

The casing of this blower is also made of boiler iron. The blades are pivoted to a shaft concentric with the casing and are revolved by means of the drum. This drum has a diameter of about two thirds that of the casing and is placed tangent to the casing between the inlet and outlet openings. The driving pulley is keyed to the shaft of the drum.

The Reichhelm Pressure Blower.

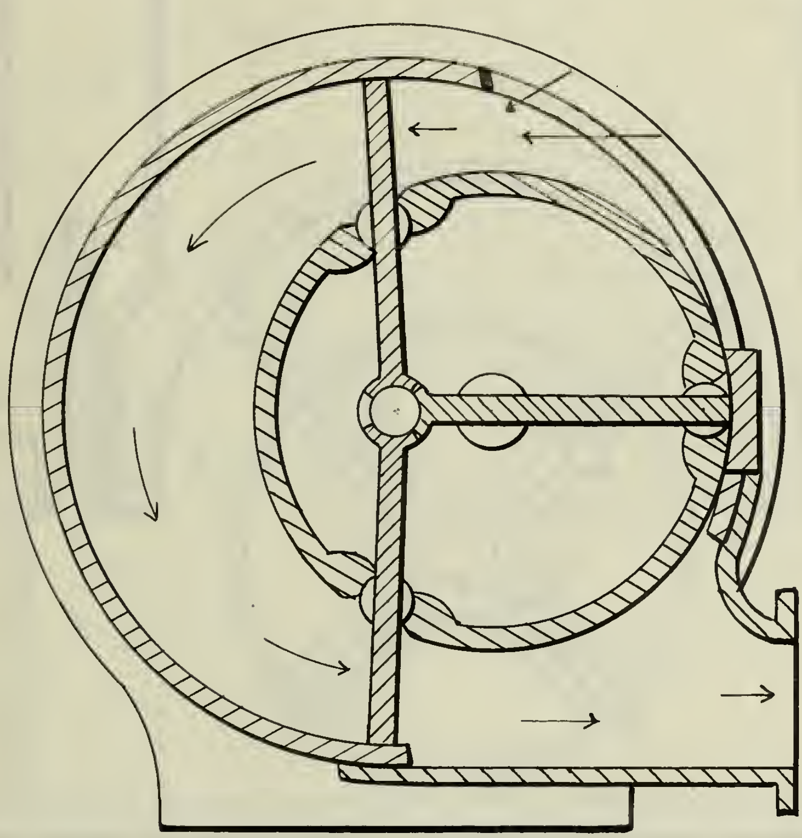
The casing of this blower is made of cast iron. A shaft which carries the driving pulley extends through the casing somewhat below the center. On this shaft a cast iron drum is fastened. This drum has four recesses into which the blades or vanes fit. A guide ring is turned into each head of the blower and into these rings are four blocks, which are pivoted to the four blades. The blades are revolved by means of the drum and are forced in and out by the guide rings and blocks. An air chamber is placed over the discharge pipe with the intention of decreasing the pulsations of the blast.

This blower is advertised in four sizes capable of discharging from sixty-five to five hundred and eighty-five feet of air at a pressure of from one pound to four pounds per square inch.

The Disstons Pressure Blower.

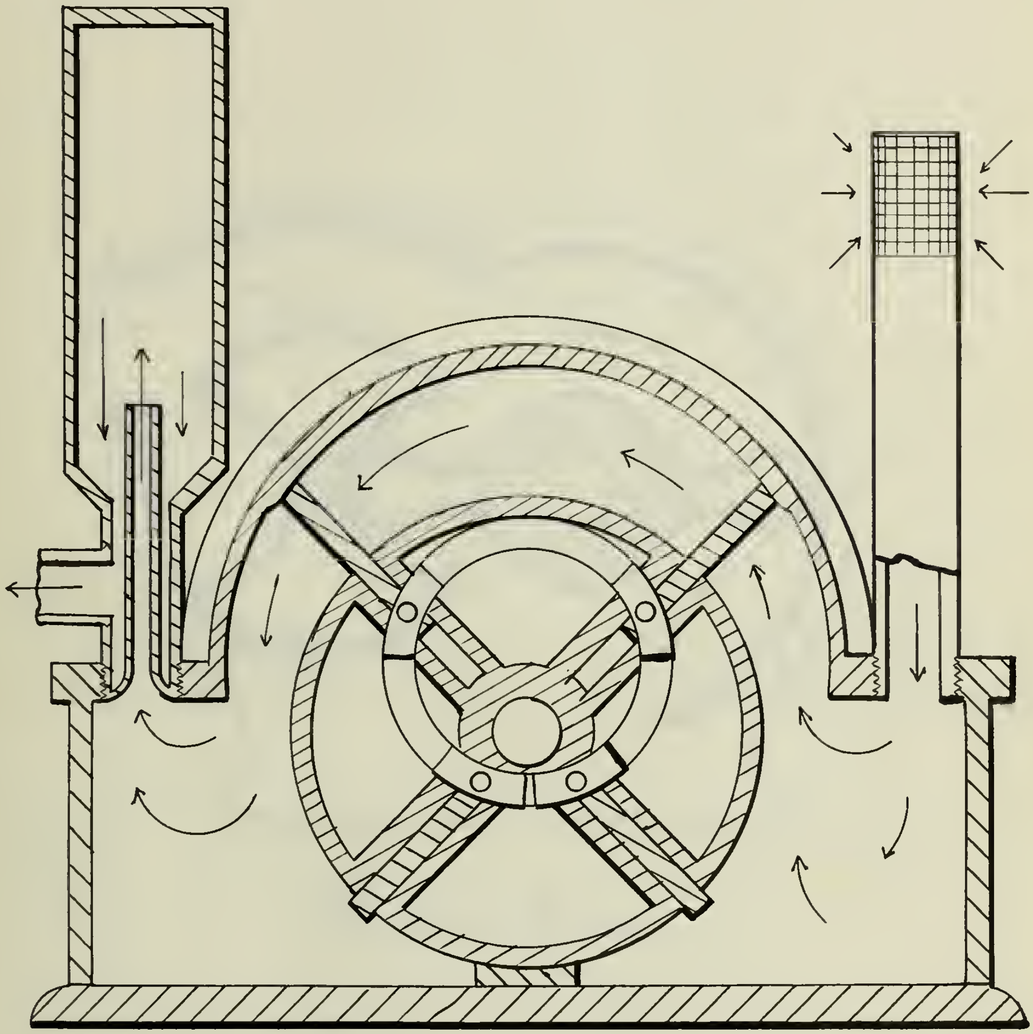
Within the casing of this machine are two revolving bodies working together as indicated and geared by a pair of equal gears on the outside of the casing. One of these bodies is a drum turned

Plate II.



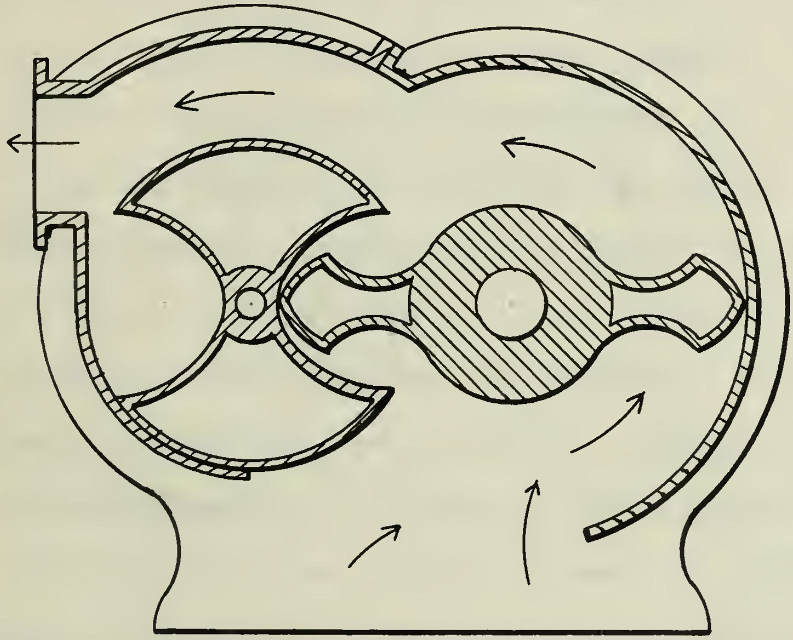
Mackenzie's Blower.

Plate III.



Reichhelm Blower.

Plate IV



Disston's Blower.

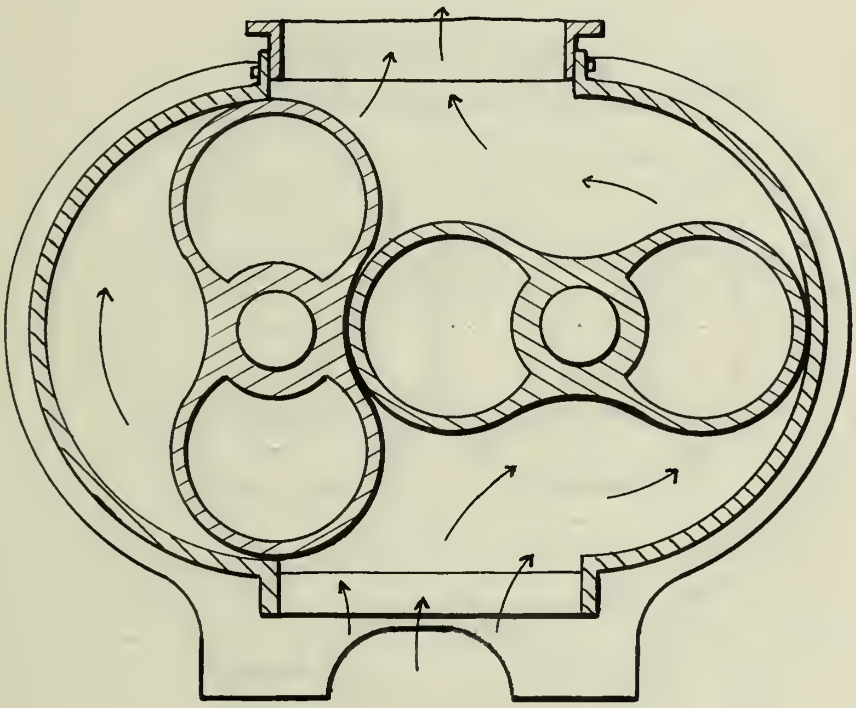
to fit the casing snugly and having two cavities for the piston to work in. The piston is also made of cast iron. This piston does nearly all of the work of the blower, only a small portion of the air that enters the cavities of the drum being forced into the discharge opening.

The Roots Blower.

This blower is made on entirely different plans from those before described. Nearly the entire machine is made of cast iron, the only other metal being the two steel shafts. The casing is oval in cross section, having the discharge and inlet openings either in the top and bottom or in the two sides of the machine. In the latter case the impellers are placed one above the other. The impellers are made of cast iron and are turned up upon a machine especially designed for the purpose. All the curves of the external surfaces are true circles. Gearing is placed on the end of the casing and the driving pulley is keyed to one of the shafts. The largest sizes of this blower are capable of discharging nineteen thousand six hundred cubic feet of air per minute at the pressures used in cupola practice.

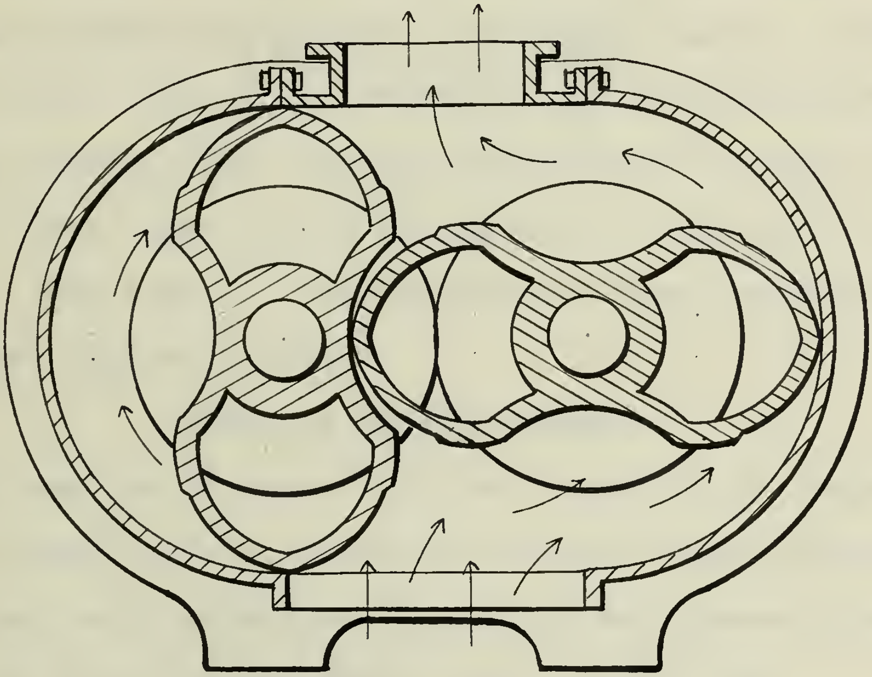
The Green's Rotary Blower.

The Green,as well as the Connersville blower,is almost exactly like the Root blower. As is shown in the drawing the impellers of the Green blower are different in design and two rollers are keyed to each shaft to prevent the impeller from pounding, should the bearings wear. The shell, gearing and other details are almost identical with the Roots. Twelve sizes are made capable



Root's Blower.

Plate VI



Green Blower.

of discharging up to 15000 cubic feet per minute.

The Connersville Blower.

All other details of this blower besides the impellers are the same as the Roots blower. The impellers of this machine are flatter at the ends and thicker at the middle. This blower is also made in sizes capable of discharging up to 15000 cubic feet of air per minute.

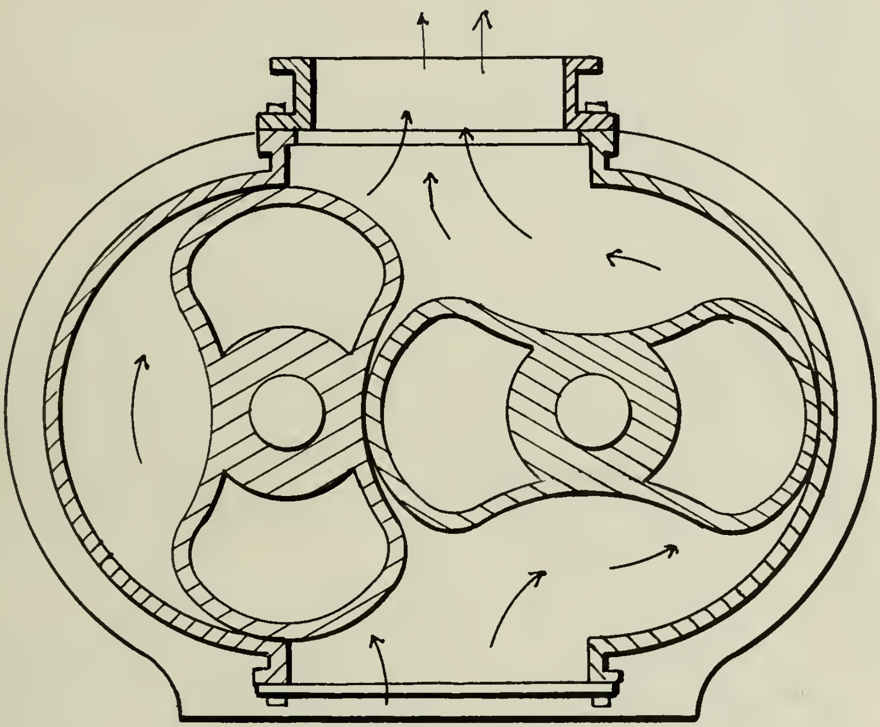
In the records of the British patent office the rotary blowers and rotary engines are described in the same volume. The rotary blowers are divided into three classes, "cresent shaped chamber types" such as the Mackenzie and Riechhelm blowers, "annular chamber type" such as the Disstons and Baker blowers, and the "Root blower type" such as the Roots, Green and Connersville blowers. Some eight or ten hundred machines are patented as blowers, rotary engines or both.

TESTS OF ROTARY BLOWERS.

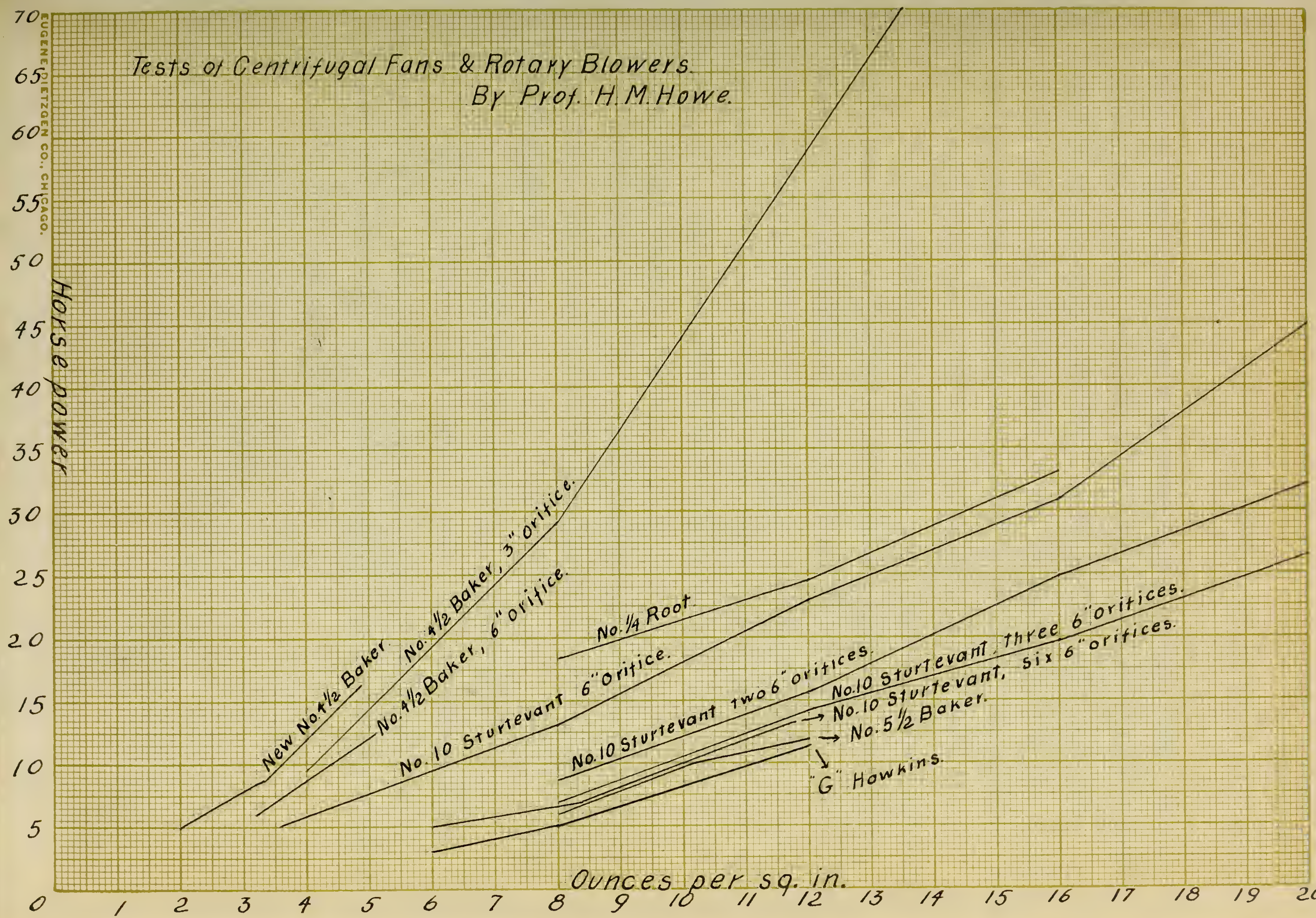
Only one set of tests of this character was found. This was a set of tests by Prof. H. M. Howe on the "Comparitive efficiency of fans and positive blowers" given in the transactions of the Institutte of Mining Engineers, Vol. 10, pg. 482.

The experiments were undertaken with the idea of proving that the Baker blower was more efficient than the fan blower. The results, much to the suprise of the authors, proved that the fan is more efficient than the Baker Blower for pressures as high as twenty ounces per square inch. The air was measured by noting the pressure of discharge through one, two or three six inch circular

Plate VII



Connersville Blower.


Tests of Centrifugal Fans & Rotary Blowers.
By Prof. H. M. Howe.
Horse power
Ounces per sq. in.
New No. 4½ Baker
No. 4½ Baker, 3" orifice.
No. 4½ Baker, 6" orifice.
No. 1/4 Root.
No. 10 Sturtevant 6" orifice.
No. 10 Sturtevant two 6" orifices.
No. 10 Sturtevant, three 6" orifices.
No. 10 Sturtevant, six 6" orifices.
No. 5½ Baker.
"G" Hawkins.
EUGENE DIETZGEN CO., CHICAGO.
0
1
2
3
4
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70

orifices and calculating the volume from these results. In comparing the results they are all reduced to the discharge through one six inch circular orifice. A No. 4 1/2 and 5 1/2 Baker blower, a No. 1/4 Root blower, a No. 10 Sturtevant fan and a "G." Hawkins fan were tested and the results plotted. The results have been copied and are given on an accompaning sheet (see pg. 15).

In his conclusion he says fans and positive blowers are more efficient when working near their maximum capacity. Therefore, when a great variation of quanity of air is required, a number of small blowers would be more efficient than one large one. The cost of positive blowers is about four times that of fans for the same capacity. The Baker blower shows about ten per cent less efficiency than the fan blowers.

This comparison is, however, severe as the pressure is somewhat lower than that for which the positive blower is designed to work against.

Constructive Features of Centrifugal Fans.

The following types of centrifugal fansare advertised by nearly every company that manufactures the centrifugal fan: Steel pressure blowers,; Volume blowers; Volume exhausters; Steel plate blowers and exhausters.

STEEL PRESSURE BLOWERS.

This is a form of fan designed to discharge a small volume of air at a high pressure. They are capable of producing a pressure of as high as twenty ounces per square inch and are adapted for use with cupolas, forges and some types of mechanical stokers.

In order to obtain a small volume and high pressure these fans are made with wheels of small widths as compared to their diameter.. The blades are usually five, six or eight in number, are wider at their inner edges than at the circumference of the wheel and are curved backwards to decrease the noise of the blast. The Sturtevant blower is made with six full blades and eighteen small blades of about half the length as the others placed in between the larger ones. The blades are riveted to steel "T" irons which are cast in the hub. Conical sideplates which extend from inlet to outlet are riveted to the sides of the blades. The casing is made of cast i iron and is of a spiral form and usually has the discharge opening horizontal. The shaft is steel and is hung in two bearings one on either side of the fan. These bearings are always large and self-oiling, the chain, ring and wick type being used. The pedestals are either cast solid to the casing or are cast separate and bolted to the casing. Both one and two driving pulleys are used. These blowers can be obtained mounted on an adjustable bed plate but are never directly connected to an engine as the relative speed is too high.

VOLUME BLOWERS.

This type of blower is designed to discharge a considerable volume of air at a moderate pressure (two to ten ounces per square inch.). In appearance they are very similar to the pressure blower. The casing, however, is wider and the outlet larger. The fan blades are of an equal width the whole length and are bent backwards the same as in the pressure blower. Only one driving pulley is used. The volume blower is also mounted on an adjustable bed plate but is never direct connected to an engine. A table of capacities of these blowers is given with this thesis.. (See pg.54).

Volume Exhausters.

The construction of a volume exhauster is similar to a volume blower except that there is only one inlet and that is provided with a flange for pipe connections. The bearings are both placed on the opposite side from the inlet and the driving pulley placed between them.

STEEL PLATE BLOWERS AND EXHAUSTERS.

These fans are designed to handle larger volumes of air at lower pressures than the volume blowers and exhausters. The casing is made of steel plate and is ribbed with angle irons to give rigidity. The fan wheels have one, two or sometimes three spiders supporting eight or more blades, the number depending upon the size of the fan. The blades are usually made straight, but in some cases where the fans must not make any noise they are bent backwards. The discharge opening can be in any direction,

top or bottom horizontal, up or down vertical, or at any desired angle. Some fans are made with two or more discharge openings. These fans are run at lower rotative speed, the speed depending upon the size. In some of the larger sizes only three-quarters of the fan is housed in steel plate, the remainder being constructed of brick, wood or some cheap material to save expense. They can be obtained with direct connected engines.

Tests of Centrifugal Fans.

"In the study of air propellers there is a great difficulty in taking correct measurements of the pressure and quantity of air delivered if the velocity of the stream is at all great. From this cause experiments apparently conducted with the greatest accuracy have often shown a fan under test to give an efficiency of over 100% and therefore, general statements of the efficiency of fans should be received with great caution."

In Vol. 123 (1895) of the Proceedingsof the Institute of Civil Engineers a set of experiments are recorded by H. Heenan and Wm. Gilbert. These experiments are very unique and are the most thorough of any that were found. They had for their object:
(1) "To determine the best shape of blade and fan case in order to obtain a minimum expenditure of power when producing any given output, i.e.- the best type of fan; (2) The standard type being elected to obtain data whereby the proper diameter of the standard fan and its most economical speed could be determined for any given output of air at required pressure.

The arrangement of the apparatus was good, great care being taken to see that there would be no doubt as to the accuracy of

the results.

"The experiments proved that a fan with a few simple blades gives the best results, provided the form of the blades and casing are designed to suit the kind of work required. Fans of a more complex design have too large an internal resistance to give a high mechanical efficiency, although they may have to be used if high pressures are essential."

Four different blades having different tip angles and different angles at the inlet, were tested in a fan of the ordinary design. A blade having a backward slope at the inlet and then bending until it is perpendicular to the circumference was found to give the best results and to maintain a high pressure as the volume increased but when the discharge approached close to the maximum it dropped rapidly to zero. A blade which sloped backward the whole length gave considerably lower efficiency, and allowed the compression to decrease rapidly as the volume increased.

In the transactions of the American Society of Mechanical Engineers a set of experiments are given by H. I. Snell on a Sturtevant blower 23" in diameter and 6 5/8 inches wide, inlet 12 1/2 inches in diameter on both sides, and eight blades having an area of 45.49 square inches.

The air was discharged through a conical tube with sides tapered at an angle of 3 1/2 degrees. Vena contracta 80%.

TABLE OF TESTS OF FANS BY H. I. SNELL.

No.	R. P.M.	Area of discharge sq. in.	Press. in oz.	Volume of air per min.	H.P.	Volume per H.P.	Theoritical volume that can be discharged per min. H.P.	Eff.
1	1519	0	3.50	0	.80	0	1048	.
2	1479	6	3.50	406	1.15	353	1048	.337
3	1480	10	3.50	676	1.30	520	1048	.496
4	1471	20	3.50	1353	1.95	694	1048	.66
5	1485	28	3.50	1894	2.55	742	1048	.709
6	1485	36	3.40	2400	3.10	774	1078	.718
7	1465	40	3.25	2605	3.30	790	1126	.70
8	1451	44	2.88	2686	3.50	767	1277	.601
9	1468	44	3.00	2752	3.55	775	1222	.635
10	1415	44	2.75	2636	3.30	799	1333	.60
11	1415	48	2.75	2873	3.45	833	1333	.613
12	1500	48	3.00	3002	3.80	790	1222	.646
13	1471	48	2.888	2938	3.70	794	1277	.626.
14	1426	89.5	2.38	3972	4.80	827	1544	.536

Experiments to dertermine the effect of speed of Fan.

R P. M.	Pressure oz.	Volume in cu.ft. per min.	H. P.	Eff.
600	.50	1336	.25	.72
800	.88	1787	.70	.61
1000	1.38	2245	1.35	.62
1200	2.00	2712	2.20	.67
1400	2.75	3177	3.45	.69
1600	3.80	3670	5.10	.74
1800	4.80	4172	8.00	.68
2000	5.95	4674	11.40	.66

In his remarks on the tests, he says, "The greatest effaciency when the discharge is free and open and the area of inlet opens equals the capacity of the fan wheel."

From experiments already given it will be seen that we may expect to receive back 65 to 75% of the power applied and no more."

There is a great variation in the opinion of different authorities as to the efficiency a fan will give. In the experiments before refered to be Heenan and Gilbert, mechanical efficiencies as high as 90% are shown. Prof. Carpenter says that any test that shows over 50% is probably in error while these experiments of H. I. Snell show as high as 74%. Weisbach and other authorities give only about 30%.

Series of Tests on Centrifugal Fan in Mechanical Engineering Laboratory, University of Illinois.

The object of this experiment was to obtain a complete set of data which would show what the fan was doing under all possible conditions.

Description of fan: The fan was a Buffalo Forge Co's "No. 8 B. Volume Blower". It is advertised for use with boilers, heating furnaces, forges and etc. The principle dimensions are:-
(See drawing plate VIII).

Height--- ----------48"

Length--- --------- 47 1/2"

Total Width.-------- 40"

Diam. of pulley ---- 8 1/2"

Width of " ----- 7 1/2"

Diam. of wheel ---- 28"

Width " " -----11"

No. of blades ----- 5", curve back ----3"

Size " " -----11"x9"--shape---

Area of blades -----88 sq. in.

Diam. of outlet (outside pipe flange)---16 1/2"

" " " (inside)---------------13"

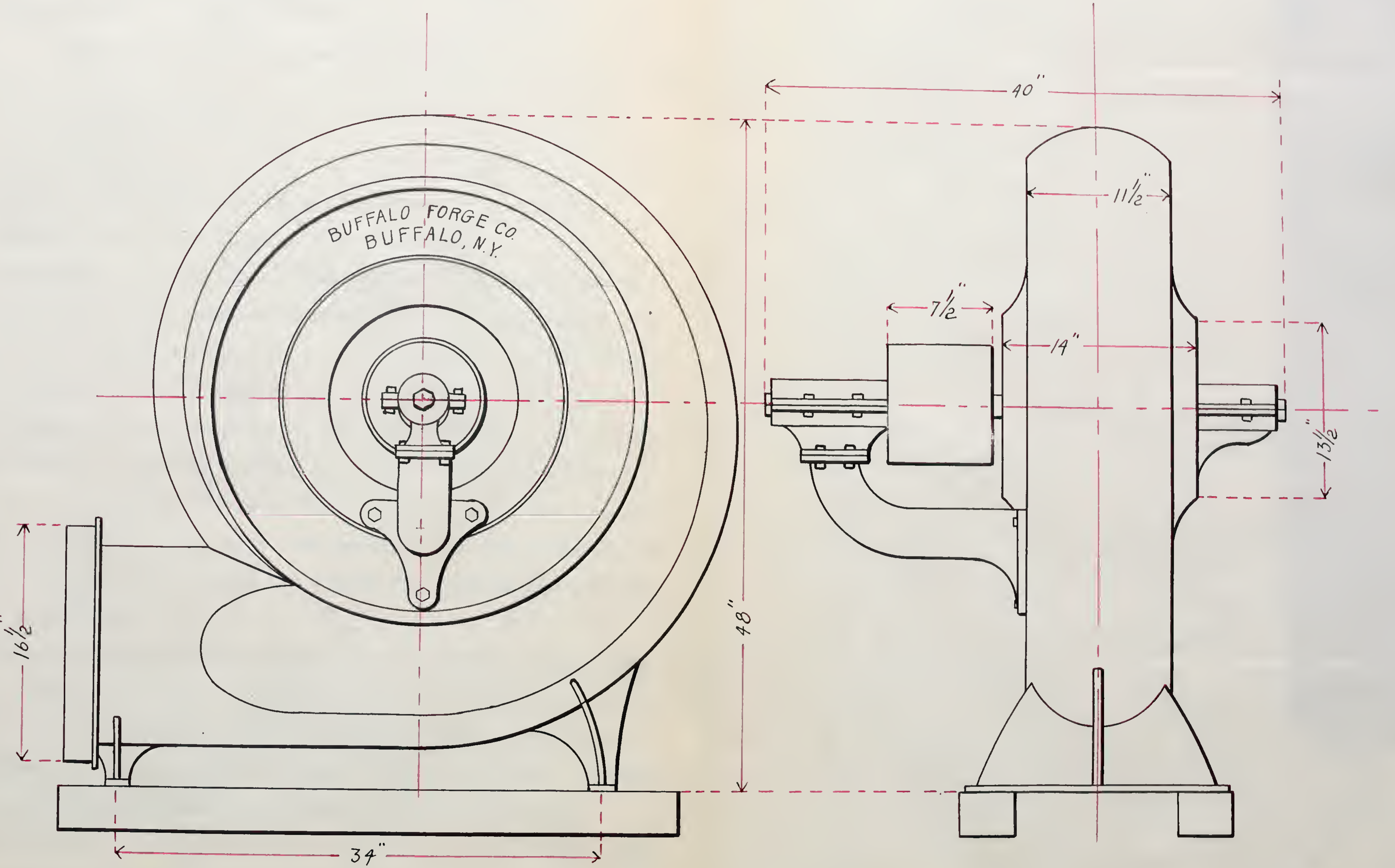
Area of outlet------132.7 sq. in.

Diam. of inlet (pulley side)-----------13 1/2"

Area of inlet (pulley side)-----------86.4 sq. in.

The area of pulley was subtracted as it obstructed

Plate VIII



the inlet.

Diam. of inlet (opposite side)----------13 1/2"

Area of inlet (opposite side)----------119 sq. in.

The area of bearing being subtracted.

$$\text{Ratio}\text{------------------}\ \frac{\text{area of inlet.}}{\text{area of outlet}}\ 1.56$$

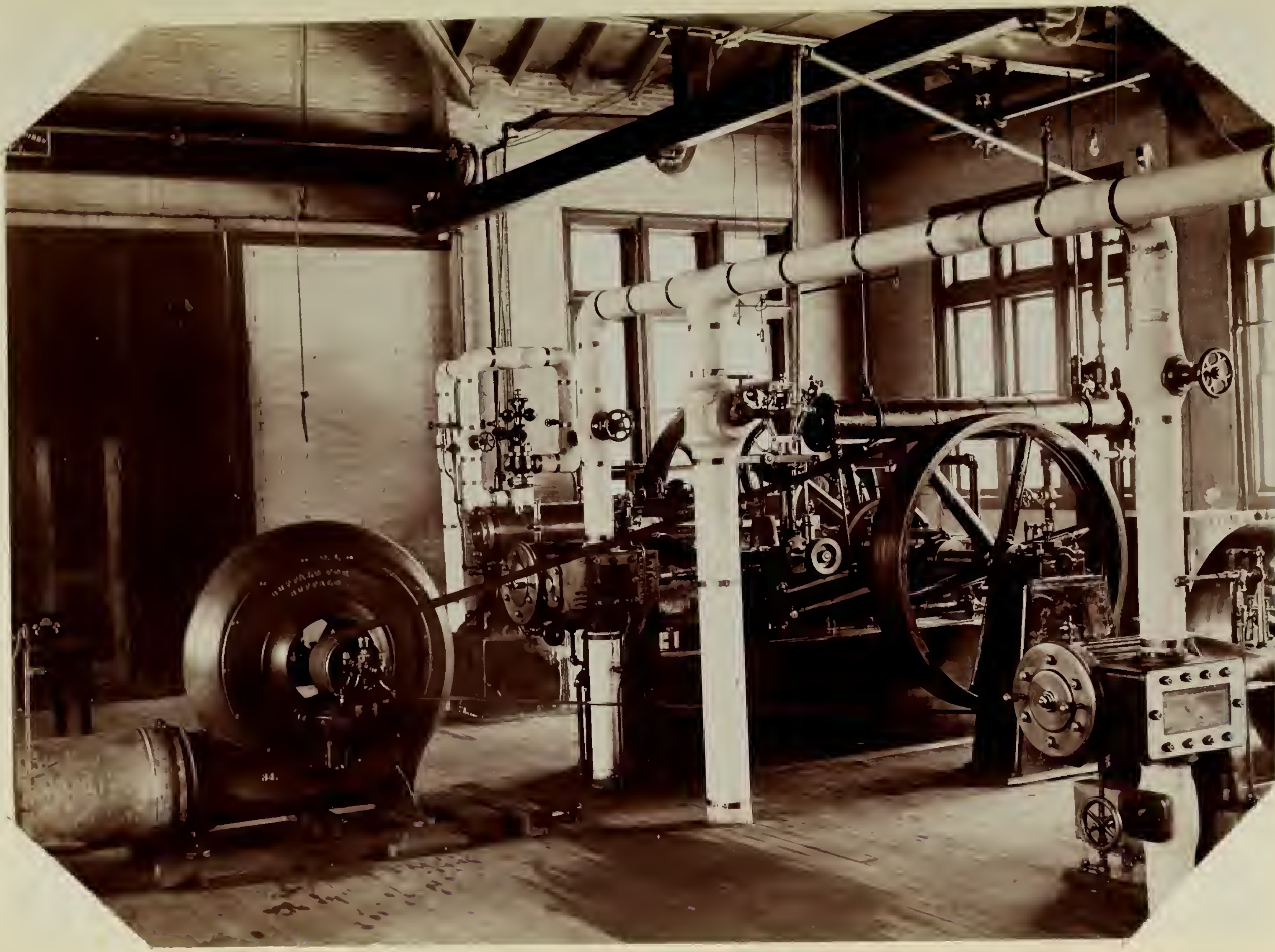
Diam. of shaft------ 1 3/4"

Length of bearings-- 9" (ring feed type)

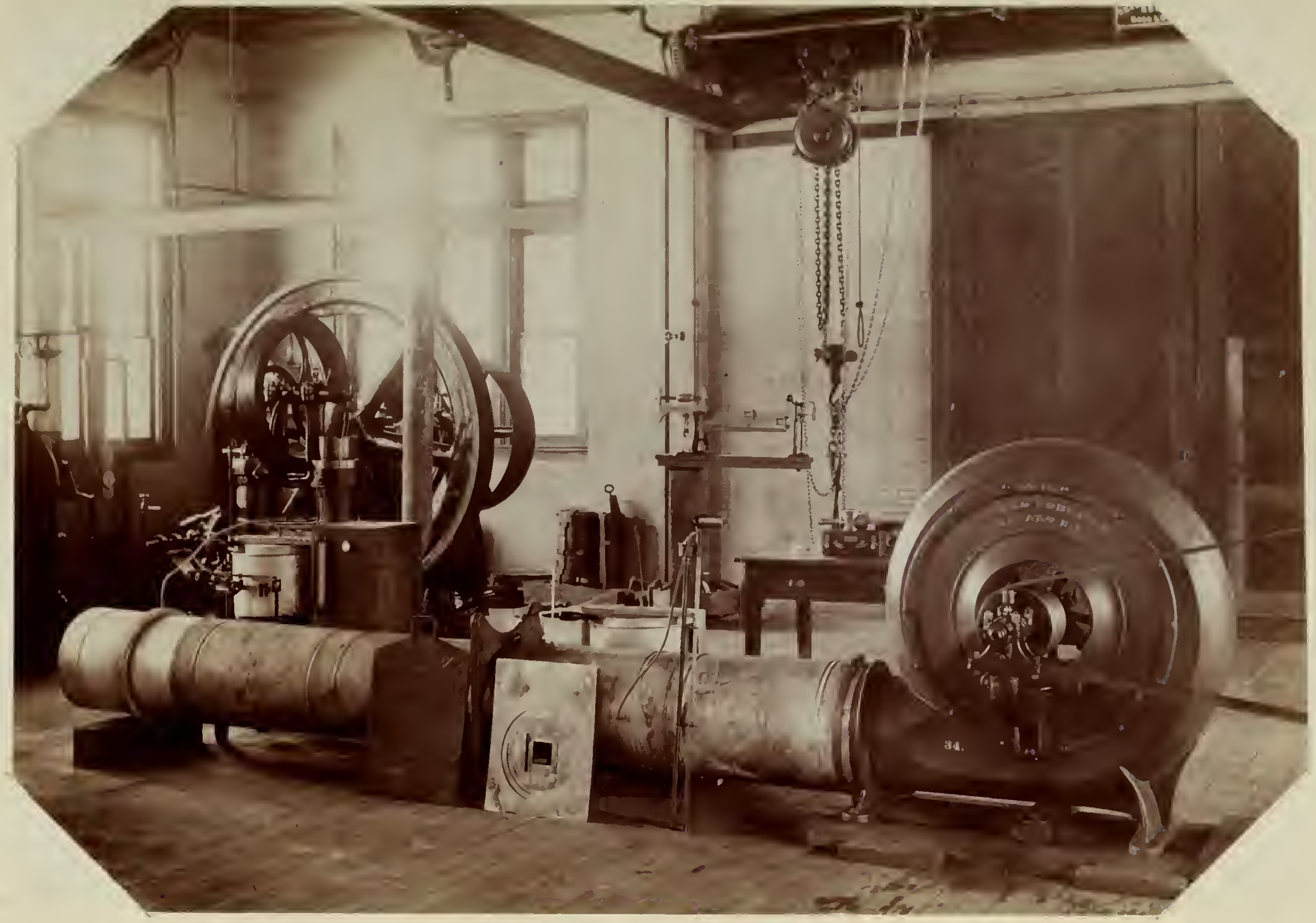
Distance between bearings---------------28"

Arrangement of apparatus:- This fan was at first belted to the Ball engine. This engine is supposed to be run at about 320 R. P. M. and has a fly wheel of 36" diameter. It was thought that the engine could be speeded up until a proper belt speed was attained buttthis was found to be impracticable. The fan was t en attached to the Myer engine. This engine has a 54" fly wheal, and is designed to run at about 250 R. P. M. But by properly arranging the weights on the governor arm and changing the ratio of the governor pulleys the engine was made to regulate to any desired speed.

Fourteen feet of 16 1/2" galvanized iron pipe was attached to the outlet of the fan. A Buffalo Forge Co., gate was placed in this pipe four and one half feet from the fan. In this gate were placed tin slides having different sized orifices. At firdt this gate was placed about six inches from the fan but the static pressure was found to vary considerable in different sections of the pipe and hence it was thought best to place the gate some distance fro the fan.



Arrangement of engine & fan.



Arrangement of piping & instruments.

The static pressure was measured in the pipe about ten inches behind the gate. The temperature was also taken inside the pipe.

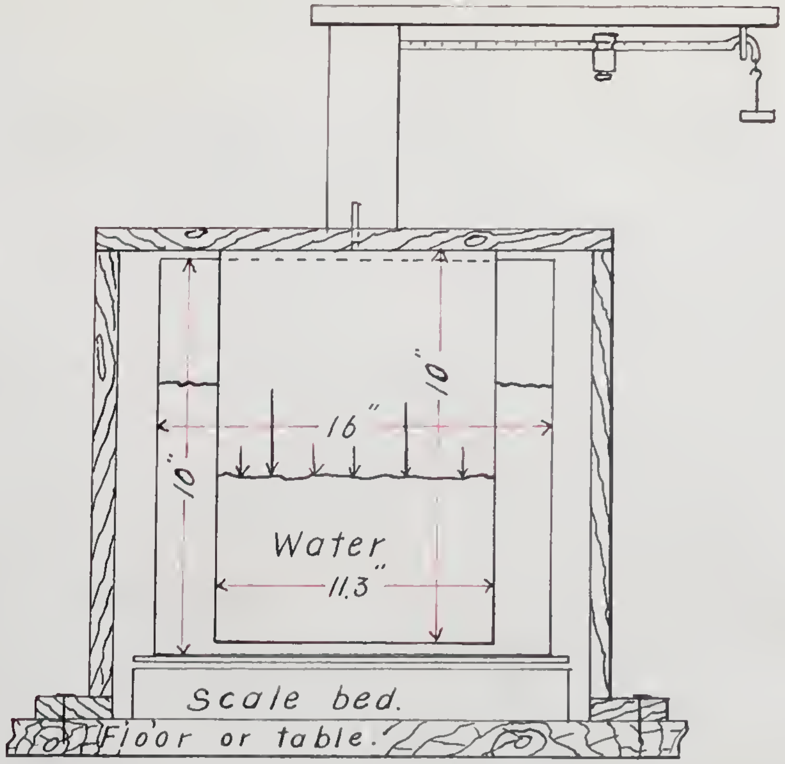
As the dynamic pressure varies considerable in different sections of the pipe a special device was made whereby one reading could be taken which would be approximately, if not exactly, an average of all the pressure in the different sections. This device shown on plate IX , consisted of nine bent tubes 1/4" in diameter which extended into the pipe and opened into the current. The ends of these tubes were so placed as to obtain the velocities for different but approximately equal areas of the cross-sections of the pipe. A hollow ring extends around this pipe and into this the tubes opened. This hollow ring acted as a chamber for averaging the different pressures. The action of this arrangement was supposed to be thus:- If the pressure in one of the nine tubes was greater than in any other then a flow of air would result, going in at the first tube and out the other until the pressure in the ring was an average between the pressures in the two tubes. The same action taking place between all the tubes would give a pressure in the ring which would be an average of all the pressures. A rubber tube was attached to this ring and to the pressure gauge.

At first an attempt was made to measure the pressure by an ordinary Pitot tube("U" tube) and water but this was found to flucuate very rapidly, thus making it impossible to obtain a reading closer than to 1/4 of an inch in water. A slanting tube was then tried but it also showed the same difficulty. Two gauges were then constructed on a plan given by Wm. Kent in Vol. 10, A.S.M.E.

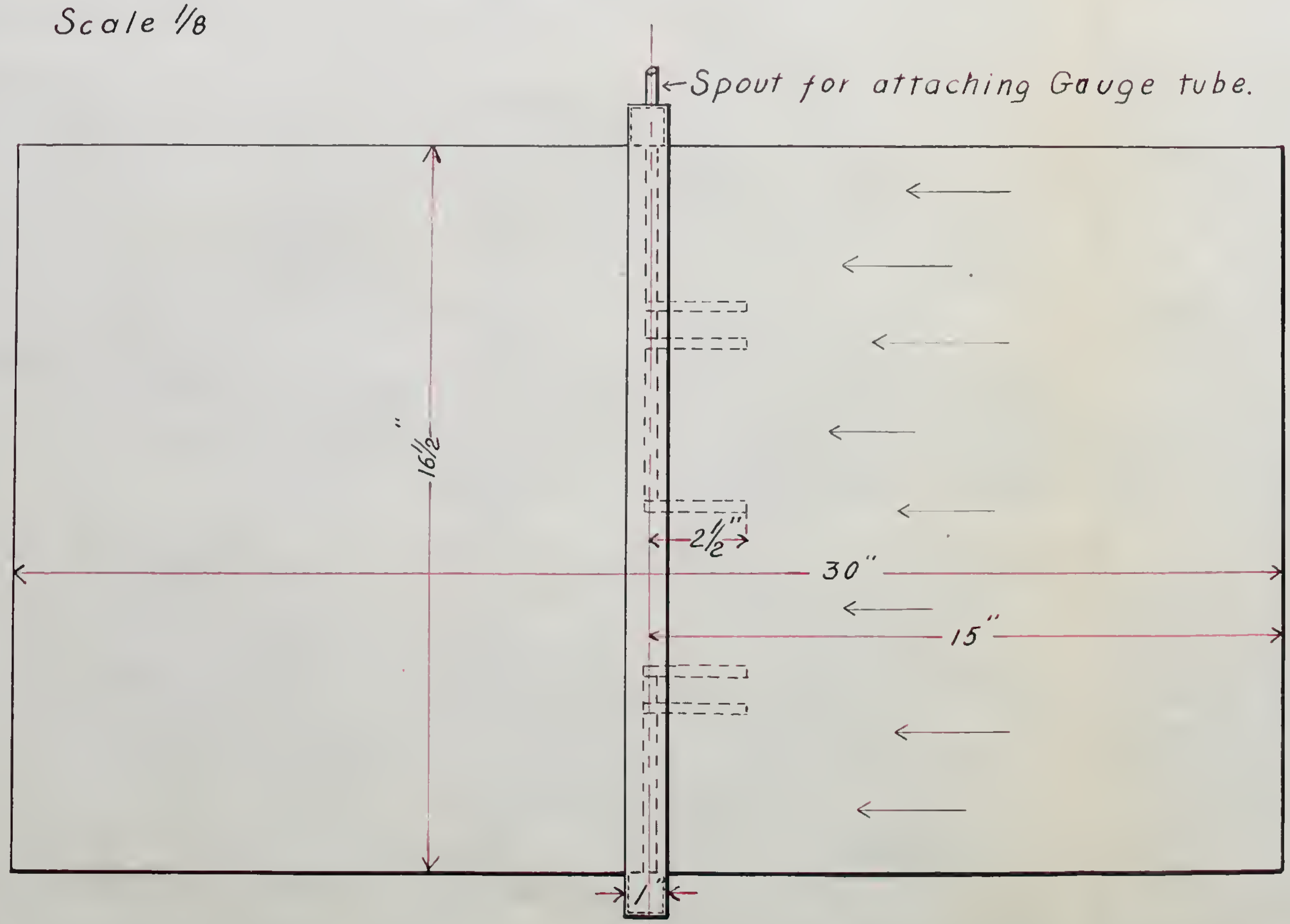
The gauges were exactly alike except that the one used to

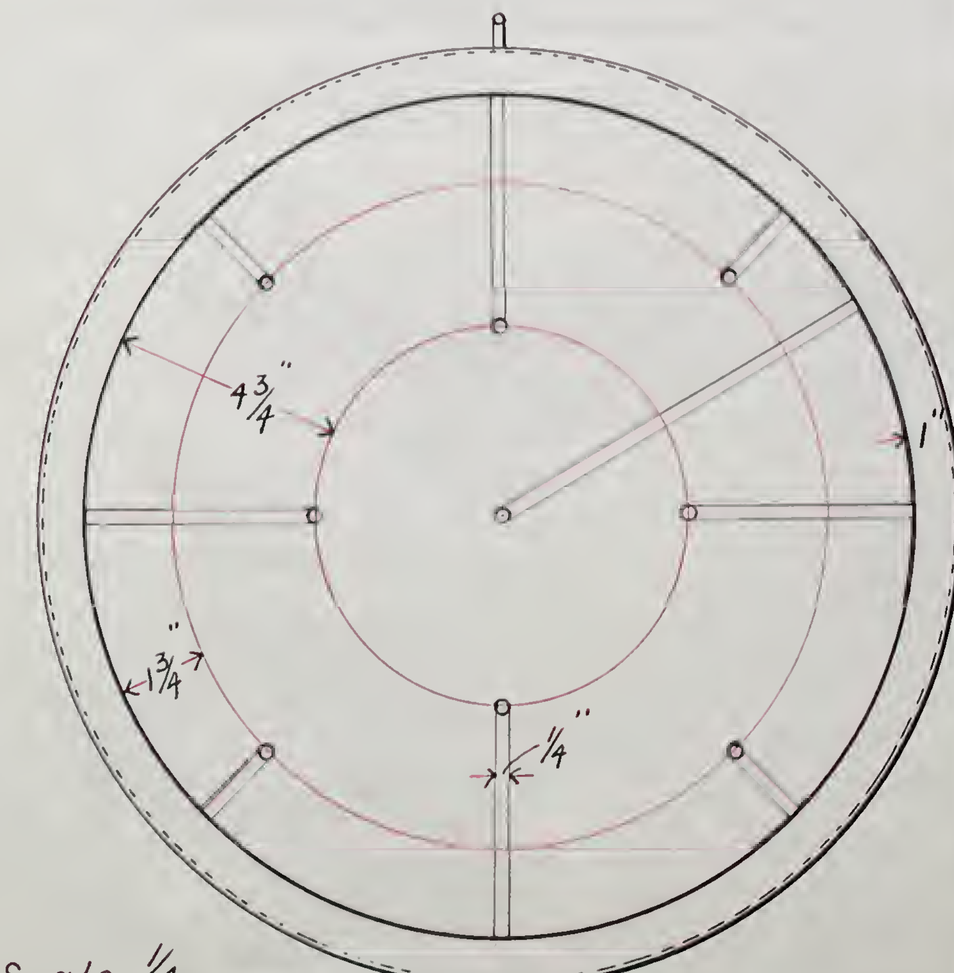
Plate IX

Details of Gauges
and
Device for obtaining dynamic pressure



Scale 1/8





Scale ¼

measure the static pressure was 24" high while the other was only 10" high.

For each gauge two pans were made, one having a diameter of about 16" and the other a diameter (11.3") such that its area was 100 square inch. The height was 24" for one gauge and 10" for the other. The 16" pan was half filled with water and placed on the platform of a pair of scales. The other pan was inverted inside this and fastened to a frame which in turn was fastened rigidly to the floor or table on which the scales rested. Care was taken to see that there was no contact between these pans. A rubber tube led from a spout in the inverted pan to the blast pipe. The pressure in the blast pipe passed through the rubber tube into the inverted pan and thus exerted a downward pressure on the water inside the pan. This total pressure was weighed on the scales. This result after being divided by 100 gave the pressure per square inch accurately to the second decimal place.

In taking readings one person took the speed of the engine while another took that of the fan, hand speed counters being used for both cases. Immediately after taking the speed one person took the indicator cards while the other took the readings from the gauges, thermometer and barometer. Seven readings were taken for each speed, one for full discharge, one for no discharge and five for intermediate discharges. Duplicate readings were taken in each case.

The method of figuring the volume was as follows:

Let V = veloc. in feet per min. of the discharge.

$V = 60\sqrt{2gh}$ where h = head in ft. air column.

$$h = 9\frac{p}{d}$$ when $p =$ pressure in ounces per sq. in. and $d =$ density.

$$\therefore V = 60 \times 3 \times 8.02 \sqrt{\frac{p}{d}}$$

Let $B =$ barometer reading in inches of mercury.

$T =$ temperature in Fahr.

$$D = \frac{1.3253 + B}{460 + T}$$ from Kent.

$$V = 60 \times 3 \times 8.02 \sqrt{\frac{(460 + T)\ P}{1.3253 + B}}$$

$$= 1254.12 \sqrt{\frac{(460 + T)\ P}{B}}$$

$Q =$ volume in cu. ft. per min.

$$Q. = 1.39 \times 1254.12 \sqrt{\frac{(460 + T)\ P}{B}}$$

$$= 1743.2 \sqrt{\frac{(460 + T)\ P}{B}}$$

$1.39 =$ area of pipe when veloc. press. was taken.

The power used was determined from the indicator cards taken from the engine. No attempt was made to separate the power used by the fan from the engine friction, the engine and fan being considered as a unit as they would occur when in use.

The results for each speed were plotted. The volume in cubic feet per minute was layed off as abscissa and the compression in ounces per square inch, the total pressure(static plus dynamic), the engine H. P., the blast H. P. and the mechanical efficiency as ordinates.

In each case the static pressure at first slightly increases with the volume and then drops radidly as the volume increases until the gate is wide open when it becomes zero.

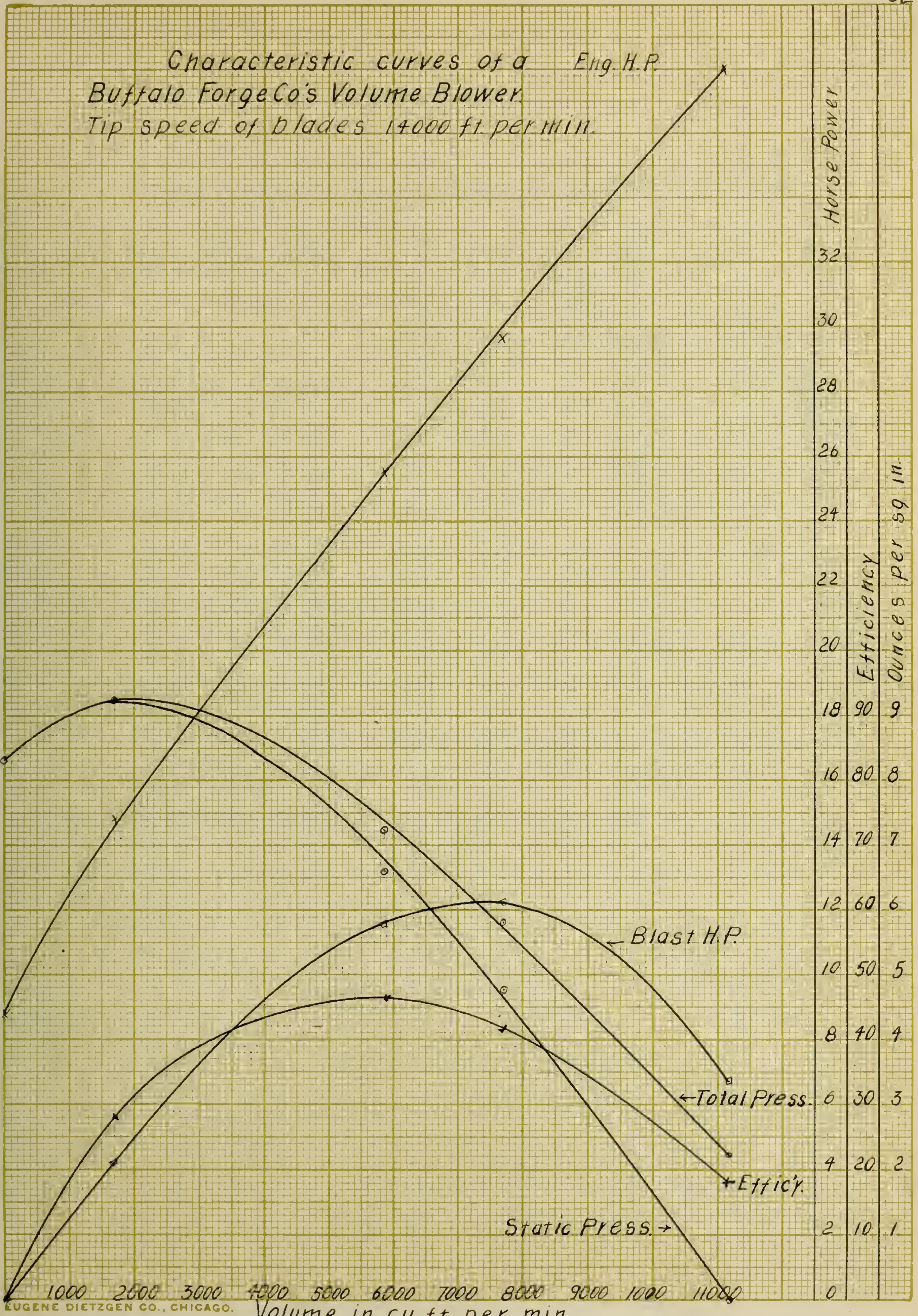
The engine horse power gives almost a straight line.

The horse power represented by the blast (which is the total pressure into the volume) increases with the volume when the pressure is high, but when the pressure becomes low and the volume large it drops off suddenly. This drop is probably due to the increased friction which the air encounters in passing through the fan. The efficiency curves also shows a similar drop, which also indicates that there is considerable lost power when a large volume is discharged.

Another set of curves is given where the volume is plotted against the speed. These show clearly that the volume varies as the speed.

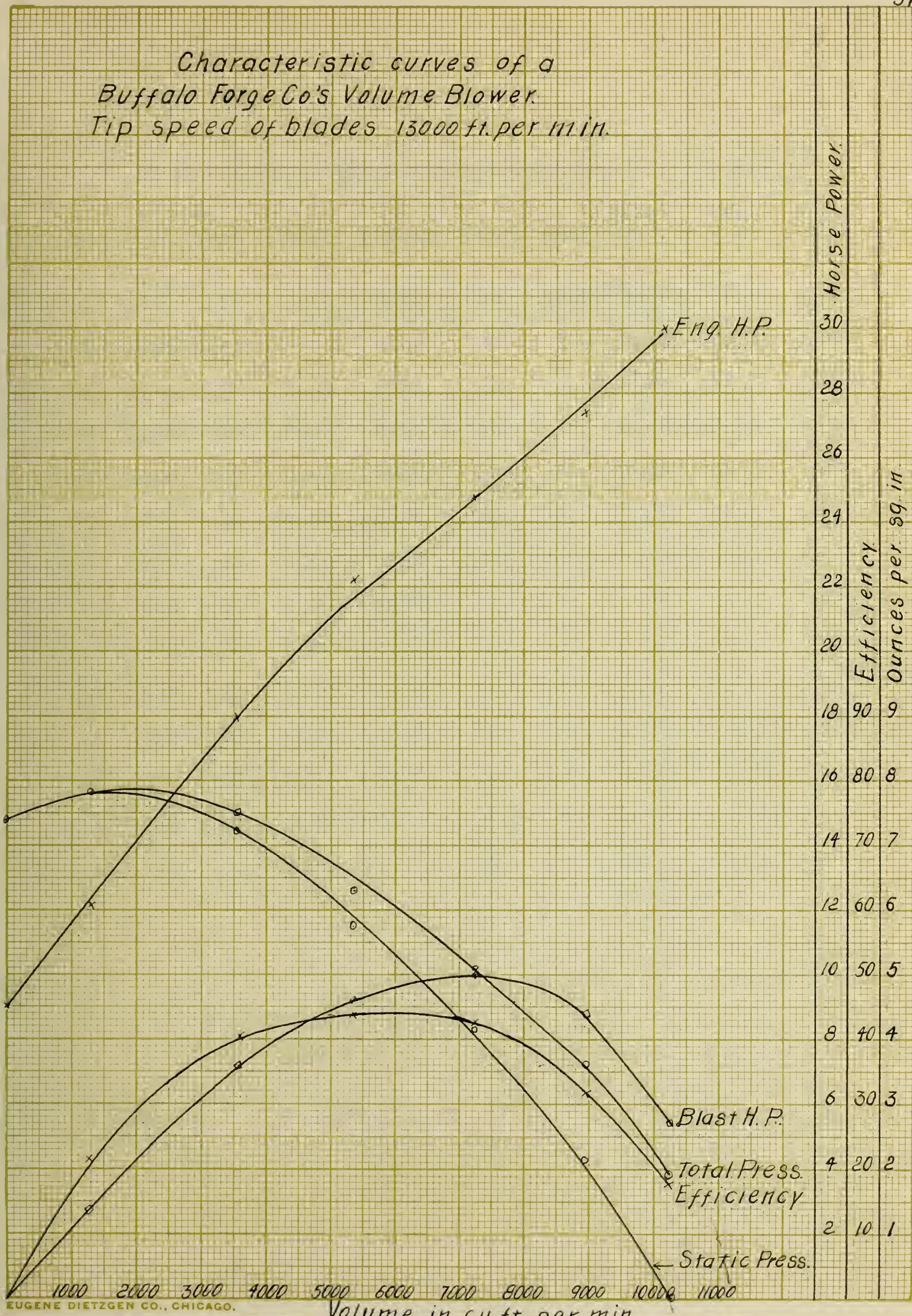
DATA & RESULTS FOR TIP SPEED OF 14000 FT. PER MIN.

No.	R. P.M.	Vel. Head.	Stat. Head	Volume	Temp.	Bar.	Blast H.P.	Eng. H.P.	Eff.
		OZ. PER SQ. IN.							
1	1900	2.26	0	11145	72	2.93	6.84	38.	.18
2	1905	1.08	4.80	7704	72	"	12.35	29.6	.415
3	1905	.63	6.624	5884	72	"	11.64	25.6	.462
4	1900	.05	9.25	1688	67	"	4.28	14.8	.282
5	1895	0	8.25	0	67	"	0	8.8	.0


Characteristic curves of a Buffalo Forge Co's Volume Blower.
Tip speed of blades 14000 ft per min.
Eng. H.P.
Blast H.P.
Total Press.
Effic'y.
Static Press.
Horse Power
Efficiency
Ounces per sq in.
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
10 20 30 40 50 60 70 80 90
1 2 3 4 5 6 7 8 9
1000 2000 3000 4000 5000 6000 7000 8000 9000 1000 11000
Volume in cu. ft. per min.
EUGENE DIETZGEN CO., CHICAGO.

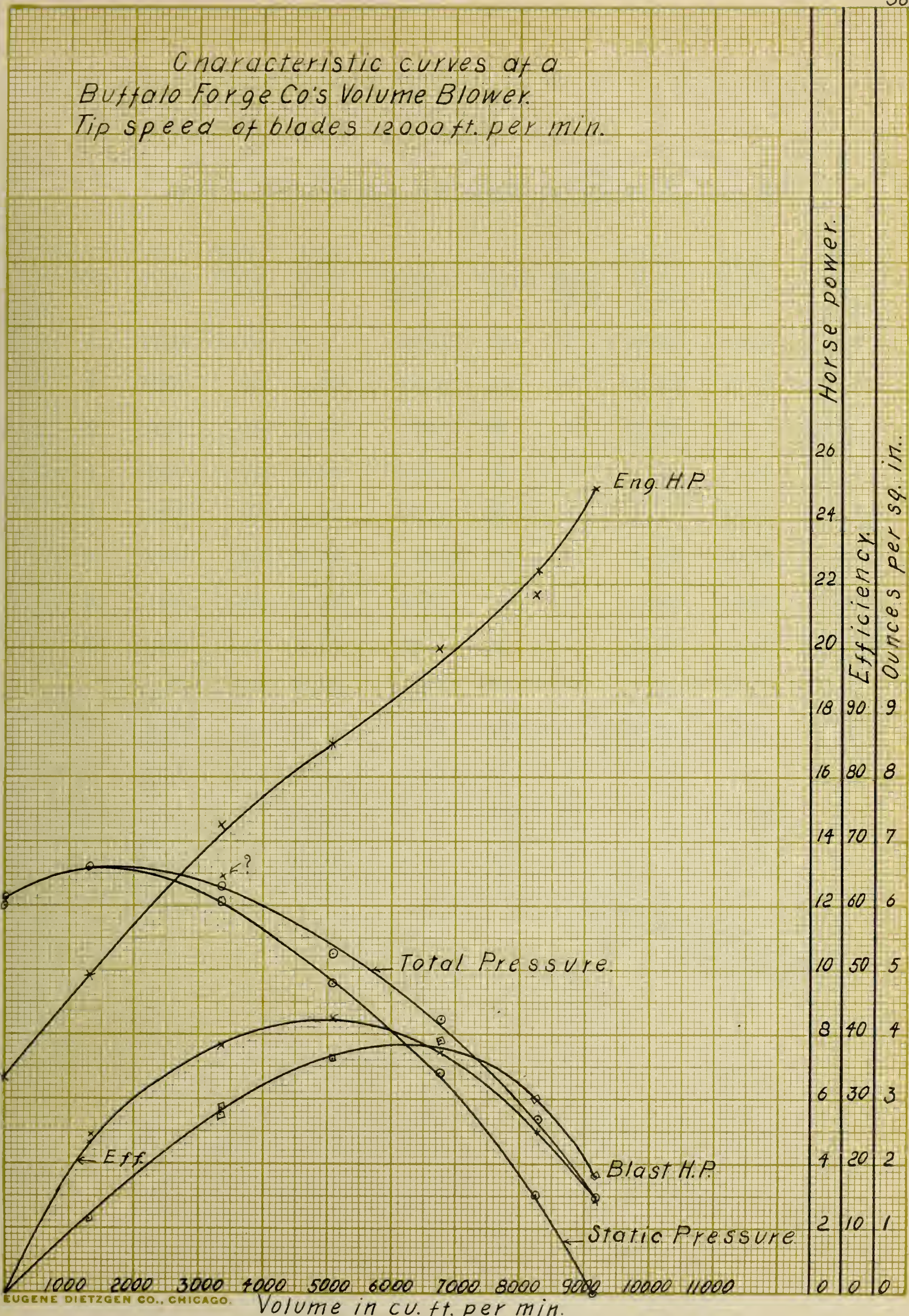
DATA & RESULTS FOR TIP SPEED OF 13000 FT. PER MIN.

No.	R P.M.	Vel. Head	Stat. Head	Volume	Temp.	Bar.	Blast H.P.	Eng. H.P.	Eff.
1	1768	1.91	0	10340	73	29.0	5.37	29.8	.181
2	1773	1.94	0	10320	73	"	5.46	29.9	.186
3	1780	1.46	2.12	8957	74	"	8.75	28.3	.31
4	1778	1.47	2.13	8988	74	"	8.82	27.7	.319
5	1780	.99	4.17	7392	73	"	10.40	25.1	.41
6	1765	.94	4.16	7187	73	"	9.996	24.4	.41
7	1778	.53	5.73	5385	71	"	9.21	22.2	.415
8	1781	.54	5.76	3631	71	"	9.25	22.1	.439
9	1769	.24	7.26	3555	71	"	7.43	17.8	.406
10	1768	.23	7.20	1284	68	"	7.20	18.	.40
11	1769	.03	7.84	1284	69	"	2.76	12.9	.213
12	1770	.03	7.82	0	69	"	2.75	12.8	.214
13	1773	0	7.37	0	70	"	0	9.	0
14	1778	0	7.39		70	"	0	8.6	0


Characteristic curves of a
Buffalo Forge Co's Volume Blower.
Tip speed of blades 13000 ft. per min.
Horse Power.
Efficiency
Ounces per sq. in.
Eng. H.P.
Blast H. P.
Total Press.
Efficiency
Static Press.
30
28
26
24
22
20
18 90 9
16 80 8
14 70 7
12 60 6
10 50 5
8 40 4
6 30 3
4 20 2
2 10 1
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000
EUGENE DIETZGEN CO., CHICAGO.
Volume in cu. ft. per min.

DATA & RESULTS FOR TIP SPEED OF 12000 FT. PER MIN.

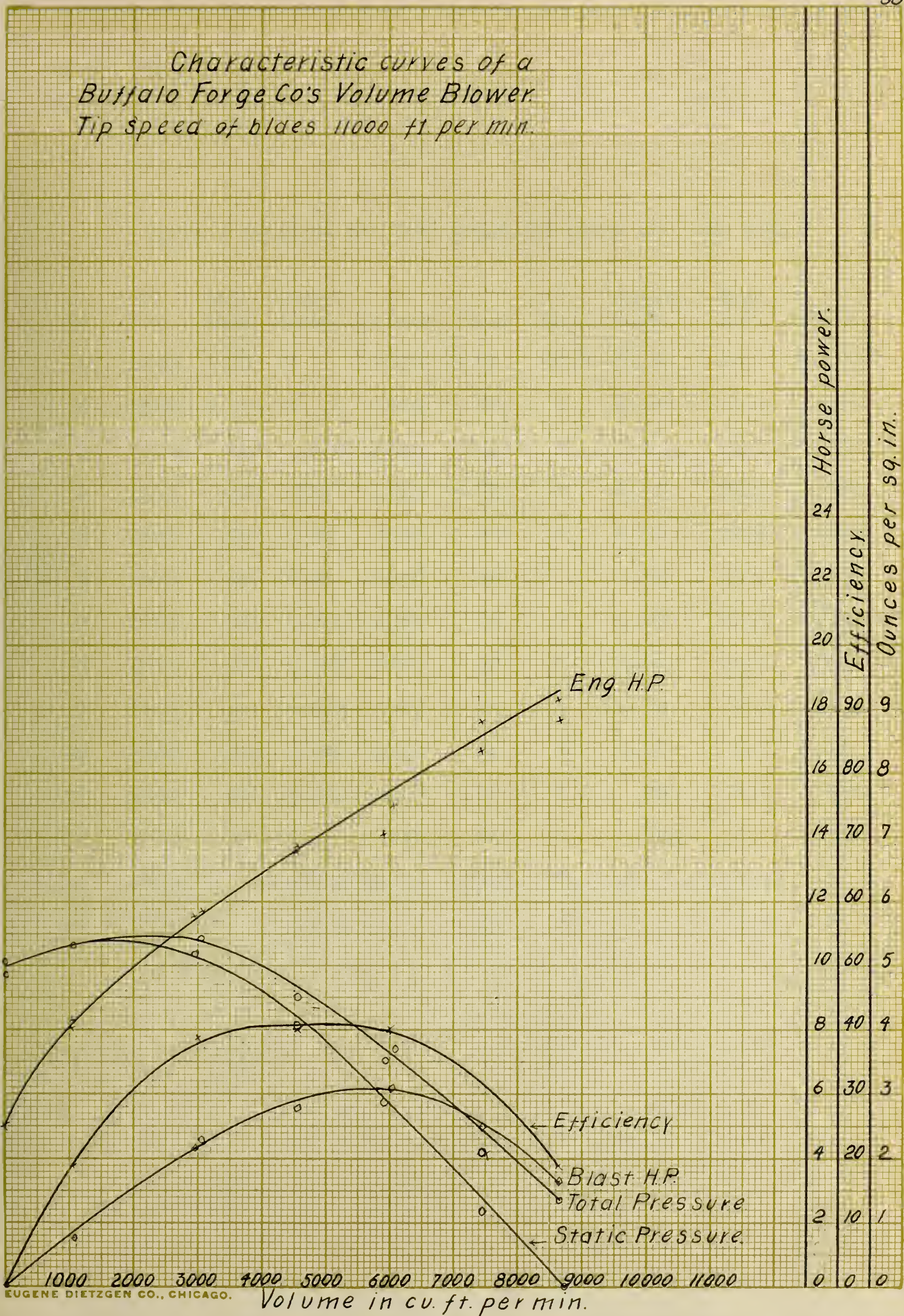
No.	R. P.M.	Vel. Head	Head	Volume	Temp.	Bar.	Blast H.P.	Eng. H.P.	Eff.
1	1640	1.49	0	9150	84	29.3	3.71	25.2	.147
2	1635	1.49	0	9150	85	"	3.71	25.1	.148
3	1610	1.20	1.50	8210	84	"	6.04	21.7	.278
4	1628	1.20	1.52	8210	83	"	6.09	22.5	.27
5	1640	.81	3.42	6740	85	"	7.77	20.7	.375
6	1650	.82	3.45	6790	86	"	7.90	19.9	.397
7	1620	.45	4.86	5030	85	"	7.26	17.1	.425
8	1630	.46	4.82	5080	85	"	7.31	17.1	.428
9	1625	.19	6.08	3270	84	"	5.58	14.6	.383
10	1622	.20	6.12	3350	84	"	5.78	13.	.445
11	1630	.03	6.64	1300	84	"	2.36	9.7	.244
12	1650	.03	6.64	1300	84	"	2.36	9.96	.237
13	1635	0	6.03	0	84	"	0	6.76	0
14	1648	0	6.16	0	85	"	0	6.34	0



Characteristic curves of a
Buffalo Forge Co's Volume Blower.
Tip speed of blades 12000 ft. per min.
Horse power.
Efficiency.
Ounces per sq. in.
26
24
22
20
18 90 9
16 80 8
14 70 7
12 60 6
10 50 5
8 40 4
6 30 3
4 20 2
2 10 1
0 0 0
Eng. H.P.
?
Total Pressure.
Eff.
Blast H.P.
Static Pressure
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000
EUGENE DIETZGEN CO., CHICAGO.
Volume in cu. ft. per min.

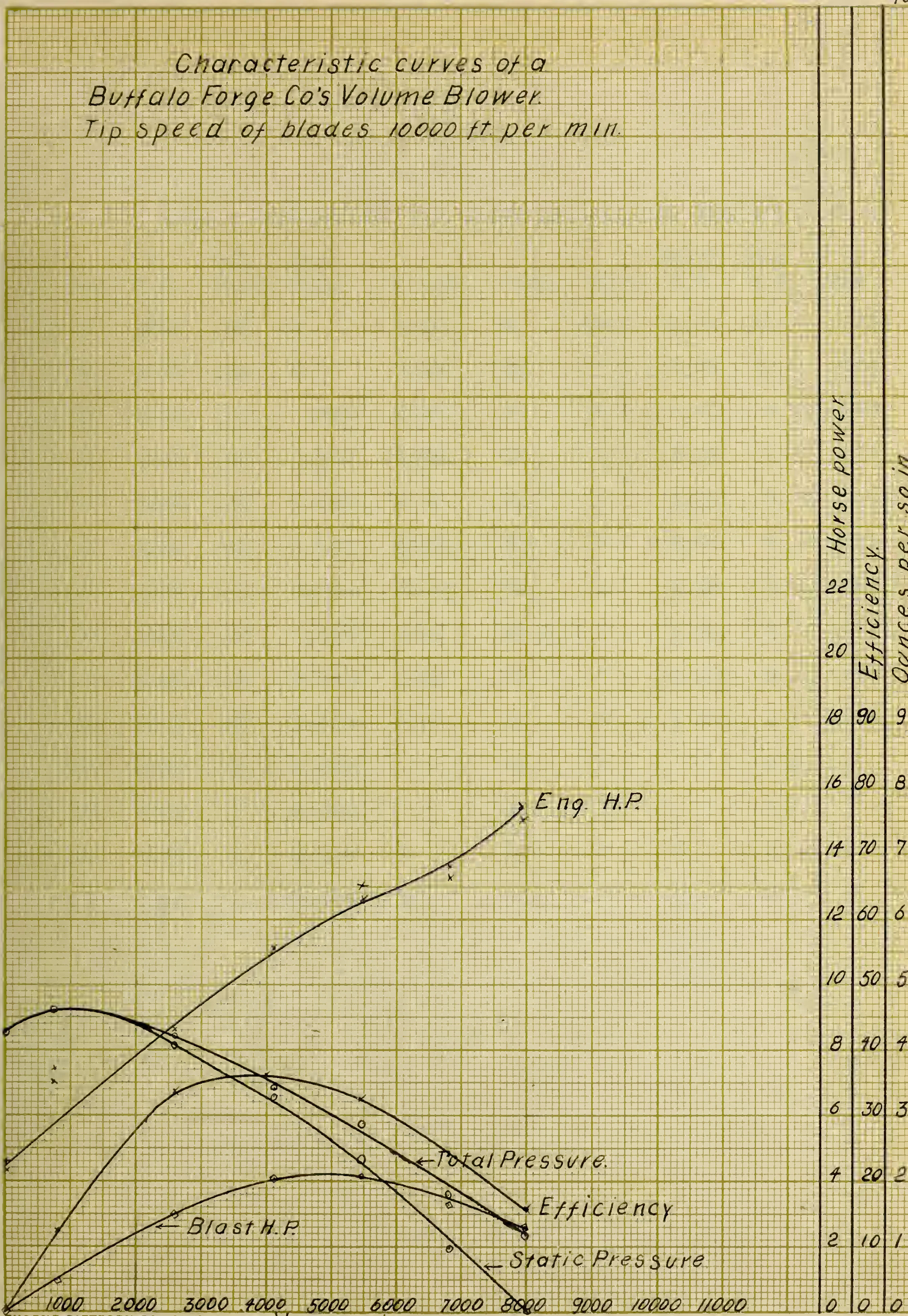
DATA & RESULTS FOR TIP SPEED OF 11000 FT. PER MIN.

No.	R. P.M.	Vel. Head	Stat. Head	Volume	Temp.	Bar.	Blast H.P.	Eng. H.P.	Eff.
1	1505	1.37	0	8753	84	29.3	3.35	17.7	.189
2	1502	1.37	0	8753	84	"	3.35	18.3	.186
3	1500	.99	1.20	7445	83	"	3.53	17.6	.200
4	1490	.99	1.20	7445	83	"	3.53	16.7	.211
5	1498	.65	3.09	6032	83	"	6.15	15.0	.41
6	1495	.63	2.90	5926	84	"	5.70	14.1	.405
7	1500	.37	4.05	4551	82	"	5.49	13.7	.40
8	1500	.37	4.08	4551	82	"	5.52	13.5	.409
9	1500	.16	5.17	2996	80	"	4.36	11.7	.373
10	1500	.17	5.34	3085	80	"	4.64	11.6	.4
11	1490	.02	5.23	1058	81	"	1.51	8.2	.188
12	1504	.02	5.34	1058	81	"	1.55	8.0	.194
13	1490	0	4.86	0	77	"	0	5.00	0
14	1498	0	5.02	0	78	"	0	4.96	0


Characteristic curves of a
Buffalo Forge Co's Volume Blower
Tip speed of blades 11000 ft. per min.
Eng. H.P.
Efficiency
Blast H.P.
Total Pressure
Static Pressure
Horse power.
Efficiency.
Ounces per sq. in.
24
22
20
18 90 9
16 80 8
14 70 7
12 60 6
10 60 5
8 40 4
6 30 3
4 20 2
2 10 1
0 0 0
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000
EUGENE DIETZGEN CO., CHICAGO.
Volume in cu. ft. per min.

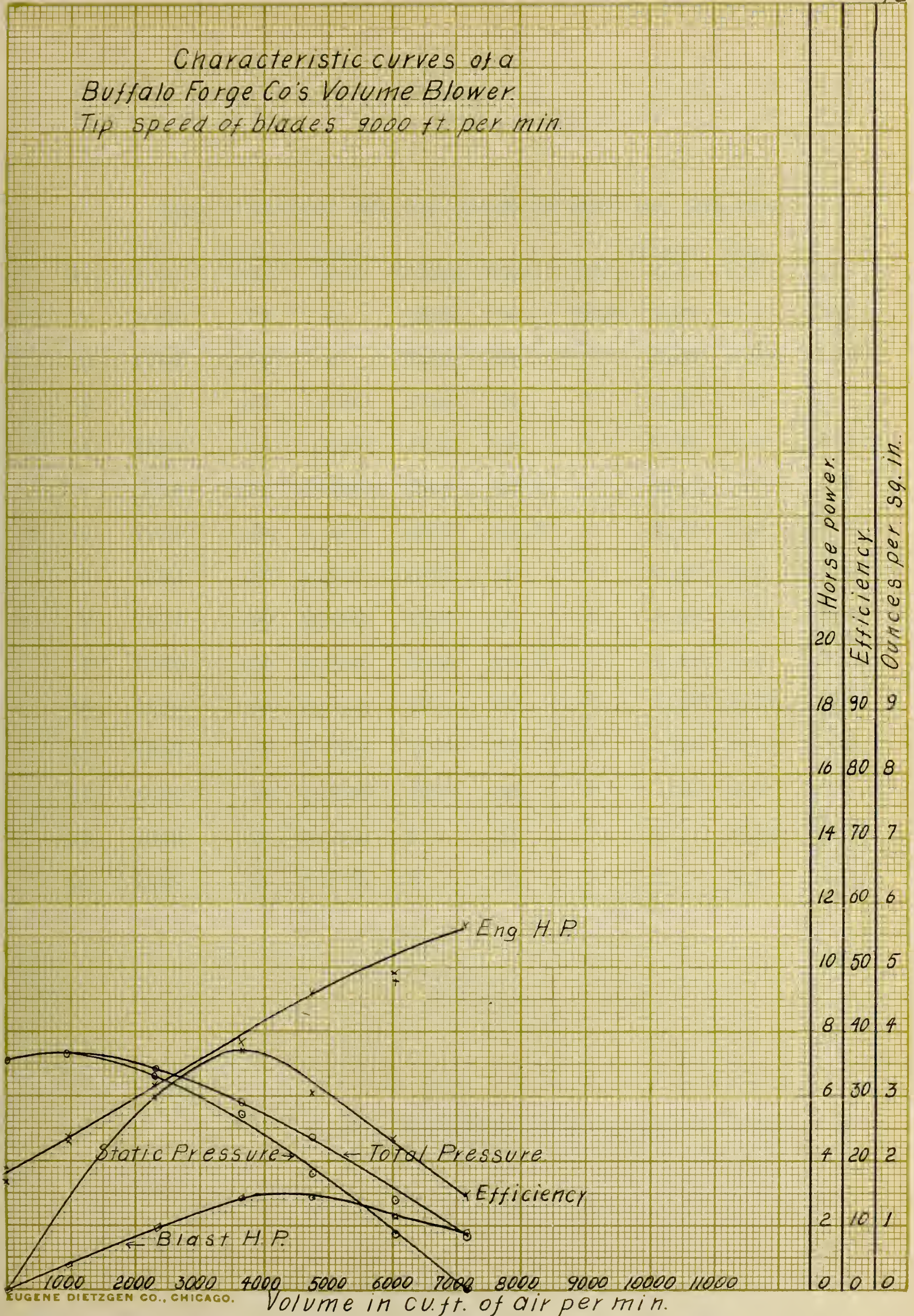
DATA & RESULTS FOR TIP SPEED OF 10000 FT. PER MIN.

No.	R. P.M.	Vel. Head	Stat. Head	Volume	Temp.	Bar.	Blast H.P.	Eng. H.P.	Eff.
1	1360	1.12	0	7919	79	29.3	2.43	15.	.164
2	1368	1.13	0	7954	78	"	2.44	15.4	.158
3	1355	.82	.928	6776	80	"	3.23	13.28	.244
4	1356	.82	.934	6776	78	"	3.23	13.5	.240
5	1365	.53	2.32	5447	80	"	4.23	13.0	.326
6	1363	.53	2.32	5447	80	"	4.23	12.6	.336
7	1365	.30	3.296	4099	80	"	4.01	11.1	.360
8	1366	.30	3.248	4099	80	"	4.01	11.1	.360
9	1365	.12	4.048	2592	82	"	2.94	8.6	.342
10	1360	.12	4.080	2592	83	"	2.97	8.5	.35
11	1368	.01	4.656	748	85	"	.952	7.4	.129
12	1372	.01	4.608	748	85	"	.921	7.	.132
13	1370	0	4.288	0	85	"	0	4.6	0
14	1368	0	4.288	0	85	"	0	4.3	0


Characteristic curves of a
Buffalo Forge Co's Volume Blower.
Tip speed of blades 10000 ft. per min.
Eng. H.P.
Total Pressure.
Efficiency
Blast H.P.
Static Pressure
Horse power
Efficiency.
Ounces per sq. in.
0 2 4 6 8 10 12 14 16 18 20 22
0 10 20 30 40 50 60 70 80 90
0 1 2 3 4 5 6 7 8 9
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000
Volume in cu. ft. per min.

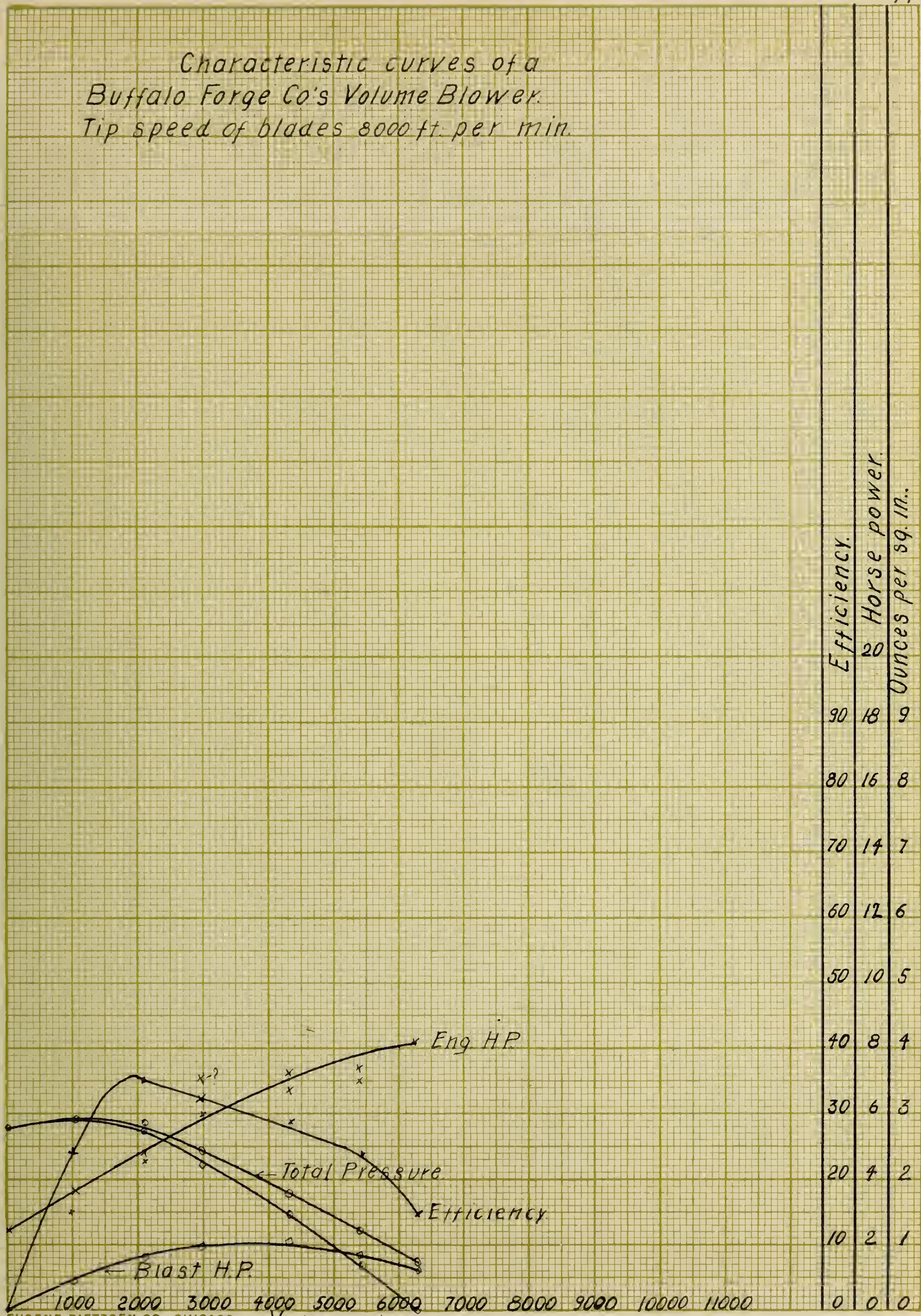
DATA & RESULTS FOR TIP SPEED OF 9000 FT. PER MIN.

No.	R. P.M.	Vel. Head	Stat. Head	Volume.	Temp.	Bar.	Blast H.P.	Eng. H.P.	Eff.
1	1226	.90	0	7123	81	29.1	1.75	11.4	.153
2	1223	.96	0	7123	80	"	1.75	11.3	.155
3	1228	.64	.832	6007	81	"	2.41	9.88	.244
4	1228	.61	.800	5864	81	"	2.25	9.68	.235
5	1230	.40	1.840	4749	81	"	2.90	9.24	.314
6	1230	.40	1.872	4749	81	"	2.90	9.16	.315
7	1227	.24	2.704	3678	81	"	2.95	7.6	.388
8	1230	.23	2.704	3601	80.5	"	2.88	7.76	.371
9	1220	.09	3.328	2252	81	"	2.10	6.38	.33
10	1225	.08	3.328	2124	81	"	1.97	6.9	.286
11	1230	?	3.632		81	"		4.8	
12	1219	?	3.520		81	"		4.6	
13	1237	0	3.568	0	81	"	0	3.46	0
14	1230	0	3.552	0	82	"	0	3.8	0

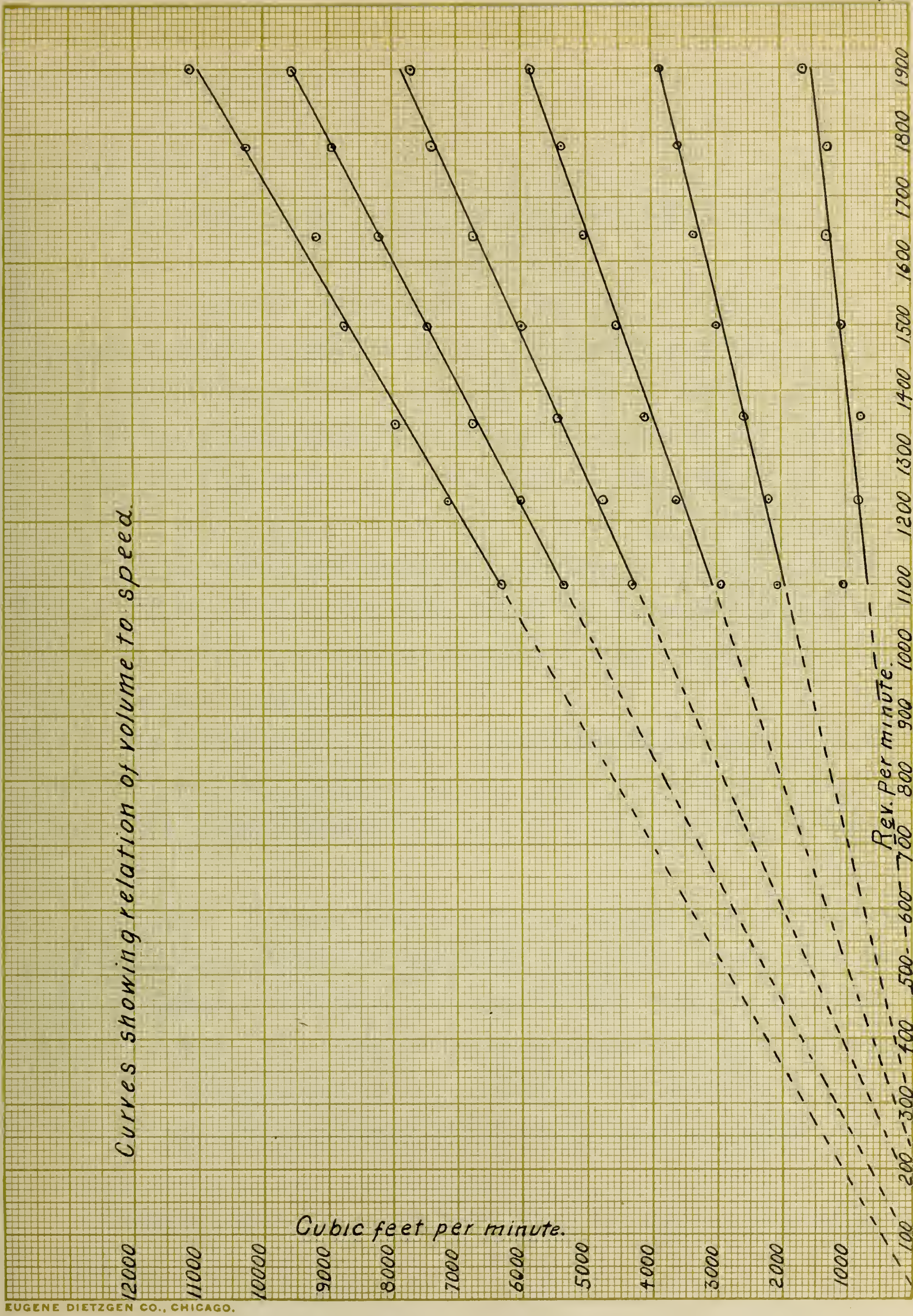

Characteristic curves of a
Buffalo Forge Co's Volume Blower.
Tip speed of blades 9000 ft. per min.
Eng. H.P.
Static Pressure→
←Total Pressure
Efficiency
←Blast H.P.
Horse power.
Efficiency.
Ounces per sq. in.
20
18 90 9
16 80 8
14 70 7
12 60 6
10 50 5
8 40 4
6 30 3
4 20 2
2 10 1
0 0 0
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000
EUGENE DIETZGEN CO., CHICAGO.
Volume in cu.ft. of air per min.

DATA & RESULTS FOR TIP SPEED OF 8000 FT. PER MIN.

No.	R. P.M.	Vel.. Head	Stat. Head	Volume	Temp.	Bar.	Blast H.P.	Eng. H.P.	Eff.
1	1095	.73	0	6325	64	29.3	1.26	8.1	.156
2	1094	..72	0	6282	64	"	1.23	8.12	.152
3	1092	.52	.688	5339	63	"	1.61	7.3	.22
4	1093	.54	.688	5441	63	"	1.82	7.4	.246
5	1095	.34	1.452	4307	63	"	2.10	7.2	.292
6	1100	.34	1.452	4307	62.5	"	2.10	6.7	.314
7	1090	.20	2.24	2951	62	"	1.95	7.1	.275
8	1097	.20	2.208	2951	61	"	1.94	6.4	.304
9	1089	.08	2.752	2094	61.5	"	1.61	4.6	.35
10	1089	.08	2.864	2094	61	"	1.68	4.75	.354
11	1090	.02	2.992	1047	61	"	.86	3.62	.238
12	1090	.02	2.992	1047	61	"	.86	3.6	.24
13	1086	0	2.784	0	61	"	0	2.56	0
14	1087	0	2.768	0	61	"	0	2.5	0



EUGENE DIETZGEN CO., CHICAGO.



Curves showing relation of volume to speed.
Cubic feet per minute.
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000 12000
Rev. Per minute.
100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900

Discussion of the principles involved in the working of Centrifugal fans.

In operation a centrifugal fan sets the air between its blades revolving about its axis. In consequence of this motion the air has imparted to it a certain amount of energy. The air leaves the blades approximately tangentially to the circumference of the wheel and with a certain velocity which depends upon the velocity of the tips of the blades. The air after leaving the blades will retain the energy thus imparted to it, in a kinetic form, if the discharge is free, but if the discharge is restricted then part of this energy will be used in compressing the air and thus assumes a potential form.

The action of the fan upon the air should be the same as a centrifugal pump, that is:- the air should be drawn in without shock and should leave the blades with a velocity equal to the tip speed.

In order to accomplish this the air should have its velocity gradually increased as it approaches the inlet. At the inlet no sudden change of volume or direction of flow should occur. The blades should slope backwards so as to gradually impart the rotary motion to the air, and the tips should be radical so as to give the air the full centrifugal force due to their tip speed. The casing should be of a spiral form.

Such a fan is never constructed, as too much expense would be involved.

The capacity of fans, expressed in cubic feet per minute, is equal to the cube of the diameter of the fan-wheel in feet multiplied by the number of revolutions and by one of the following constants:

For a fan with single inlet and delivering the air without pressure .6, when delivering air with pressure of 1 inch of water .5. For fans with double in lets the constants should be increased by 50 per cent. (Prof. R. C. Carpenter).

The horse power required is equal to the fifth power of diameter in feet, multiplied by the number of revolutions per second, divided by 1,000,000 and multiplied by one of the following constants: free delivery- 30, delivery against one ounce pressure 20, delivery against two ounces 10. (R. C. Carpenter.)

The following references are thought to contain the best information upon this subject.

621.623 Efficiency of fans and blowers.

A. S. C. E.

Vol. 7. Experiments by W. T. Trowbridge and Geo. A. Souter

also to determine the volume of air delivered under

E. N. various conditions and the power required.

Dec., 11, '96.

621.623

Lon., Eng. Testing of fans and blowers.

July 24, '85.

Prof. R. [illegible]. Smith.

To find (1) how much work is required to be done by a proposed fan (2) how much mechanical work is done by a fan in place.

621.623

P. I. C. E. On the conditions and limits which govern the

30:276 proportions of rotary blowers.

Robert Briggs.

Year '70. (83 p. 5 d)

Gives opinions of various authorities and conclusions. Good explanation of working of fan.

621.623	
P. I. C. E.	The design and testing of various types of centrifugal fans.
123:272	
	H. Heenan & W. Gilbert.
Dec. '95.	(55p. 31)
	Gives results of elaborate experiments on the efficiency of fans and deduces characteristics curves that may be employed in the design of a fan with maximum efficiency for a given duty.
621.623	Centrifugal fans.
Amer. Inst.	R. Van A. Norris.
Min. Eng.	
20:637	
Year'92.	Twenty-nine tests of nine ventilating fans: tabulated data and results: discussions.
621.623	Investigation of a blowing fan.
E. R.	Prof. R. C. Carpenter.
39:310	
	Elaborate test conducted at Cornell University. Numerous curves of working of fans with different shaped blades.
621.623	
H. & V.	Same as above.
IX: 2: 7	
Feb., '99	

621.623
H. & V. Theory of centrifugal fans, or rotary blowers.
9: 2: 7

Prof. R. C. Carpenter.

Feb. '99. Deduces a theory. Gives theoretical formulae for the volume and horse power required. A simple practical formulae for volume, also one for horse power required.

621.623
H. & V. Methods of testing blowing fans.
9: 1: 3.

Prof. R. C. Carpenter.

Jan. 1900 Gives descriptions of numerous methods of measuring pressures. Opinions of each method. Cuts of different gauges.

621.623 Efficiency of fans and blowers.
Lon. Eng.

Nov. 14, '84 An editorial in which a new formula for computing the H. P. is given by Prof. Herschel. Discussion by W. C. Nnwin.

621.623
A. S.M. E. Experiments and experiences with blowers.
9:51

H. I. Snell.

Year '87.	(22p. 1i, 5t)
	Gives tables of experiments and methods of taking same. Method of piping. Two fans should never discharge into same pipe.
621.623.	
P. I. C. E.	Manometer and mechanical efficiency of fans.
66:271	
	Explains and discusses above. Gives formulae.
621.623	
A. M.	Power required to drive centrifugal fans.
19:1218	
	(2p. 2 i)
Dec. 31, '96.	Results of tests by Interior Conduit & Insulation Co., who furnished motor.

Size.
30"
35"
40"
45"
50"
55"
S.P.P.M. 60"
3 x 4½ 60"
3½ x 5¼ 70"
4 x 6 80"
4½ x 6¾ 90"
5 x 7½ 100"
5½ x 8¼ 110"
6 x 9 120"
7 x 10½ 140"
8 x 12 160"
9 x 4½
10 x 5
12 x 6
30"
35"
40"
45"
50"
55"
S.P.P.M. 60"
3 x 4½ 60"
3½ x 5¼ 70"
4 x 6 80"
4½ x 6¾ 90"
5 x 7½ 100"
5½ x 8¼ 110"
6 x 9 120"
7 x 10½ 140"
8 x 12 160"
9 x 4½
10 x 5
12 x 6

C. S. Joh

Mechanical Engineering Dep't. University of Illinois.

Steel Plate Fans.

Table of Speeds, Pressure in Ounces, Capacity in Cu. Ft. of Air per Min. & Power Required.

Size.	Wheel Dia. Inlet	Wheel Dia. D Wheel	Wheel Width. Inlet	Wheel Width. W Outlet	Sq. inches of Blast. DW 3	Sq. inches of Blast. DW 2	Circum. Wheel.
30"	12½	18	8¼	6	36	54	4.7'
35"	14	21	9½	6⅞	48	72.2	5.1'
40"	16	24	11	7⅞	63	94.6	6.3'
45"	18	27	12¾	9½	85.5	128	7.1'
50"	21	30	13½	10¼	102.5	154	7.85'
55"	22	33	15⅝	11¾	129	194	8.6'
S.P.P.M. 60"	24	36	16⅝	12⅜	148	223	9.4'
3 X 4½ 60"	27¾	36	16⅝	15⅛	181.5	273	9.4'
3½X5¼ 70"	31	42	19⅜	16¾	234	352	11.'
4 X 6 80"	36	48	22½	18¾	300	450	12.5'
4½x6¾ 90"	38	54	26	22⅝	408.5	610	14.1'
5 X 7½ 100"	42	60	30	24¼	486	728	15.7'
5½X8¼ 110"	47	66	34¾	29	638	957	17.2'
6 X 9 120"	52	72	40½	35¼	846	1270	18.8'
7 X10½ 140"	60	84	45¾	40¼	1127	1700	22.'
8 X 12 160"	68	96	45¾	39	1250	1870	25.'
9 X 4½		108	51½	44¼	1590	2400	28.2'
10X5		120	57¾	50¼	2010	3020	31.4'
12x6		144	69½	59½	2860	4280	37.4'

Size.	⅛ Ounce Rev.	Cu. Ft.	H.P.	¼ Ounce Rev.	Cu. Ft.	H.P.	⅜ Ounce Rev.	Cu. Ft.	H.P.	½ Ounce Rev.	Cu. Ft.	H.P.
30"	389	458	.0234	550	647	.066	674	793	.122	777	915	.187
35"	359	610	.0313	507	862	.088	622	1057	.162	716	1220	.25
40"	291	800	.041	410	1130	.1155	503	1385	.213	580	1600	.328
45"	258	1085	.0556	364	1530	.1560	445	1880	.288	517	2180	.444
50"	233	1300	.0667	329	1840	.188	403	2260	.347	465	2610	.533
55"	213	1620	.084	300	2320	.237	368	2840	.437	424	3280	.672
S.P.P.M. 60"	195	1880	.0965	275	2660	.272	337	3260	.502	389	3760	.772
3 X 4½ 60"	195	2260	.118	275	3200	.333	337	3920	.610	389	4520	.942
3½X5¼ 70"	166	2980	.152	235	4200	.43	288	5150	.792	333	5940	1.22
4 X 6 80"	146	3810	.195	207	5380	.55	254	6600	1.01	293	7620	1.56
4½x6¾ 90"	130	5180	.264	183	7330	.745	225	8970	1.37	260	10350	2.12
5 X 7½ 100"	116	6070	.315	165	8720	.888	202	10700	1.64	233	12300	2.52
5½X8¼ 110"	106	8100	.414	150	11450	1.17	184	14050	2.15	213	16200	3.32
6 X 9 120"	97	10750	.555	137.5	15200	1.56	164	18600	2.88	195	21500	4.40
7 X10½ 140"	83	14400	.736	117.5	20200	2.08	147	25000	3.82	167	28600	5.88
8 X 12 160"	73	15900	.81	103.	22400	2.28	127	27500	4.21	147	31800	6.47
9 X 4½	65	20200	1.04	91.6	29200	2.84	112	35000	5.4	130	40400	8.3
10X5	58	25000	1.31	82.3	36100	3.68	101	44300	6.8	117	51100	10.45
12x6	49	36300	1.85	69	51300	5.23	84.5	63000	9.63	97.7	72700	14.80

Size.	⅝ Ounce Rev	Cu Ft.	H.P.	¾ Ounce Rev	Cu. Ft.	H.P.	1 Ounce Rev	Cu. Ft.	H.P.	1¼ Ounces. Rev.	Cu. Ft.	H.P.
30"	868	1020	.262	952	1120	.344	1100	1290	.53	1230	1440	.74
35"	800	1360	.35	878	1490	.46	1015	1725	.705	1140	1920	.99
40"	648	1790	.458	714	1960	.603	822	2260	.927	929	2520	1.295
45"	575	2430	.62	634	2660	.816	732	3070	1.26	820	3420	1.76
50"	520	2920	.745	570	3190	.980	660	3690	1.51	738	4120	2.11
55"	424	3660	.948	521	4020	1.23	602	4640	1.90	674	5190	2.66
S.P.P.M. 60"	434	4200	1.08	477	4610	1.42	551	5320	2.18	617	5930	3.06
3 X 4½ 60"	434	5060	1.31	477	5540	1.71	551	6400	2.67	617	7160	3.74
3½X5¼ 70"	372	6650	1.70	407	7280	2.24	470	8420	3.45	528	9410	4.83
4 X 6 80"	326	8530	2.18	358	9340	2.86	414	10800	4.41	464	12030	6.18
4½x6¾ 90"	289	11550	2.95	318	12700	3.88	367	14700	5.98	411	16400	8.38
5 X 7½ 100"	260	13800	3.52	285	15100	4.64	330	17400	7.13	369	19500	9.97
5½X8¼ 110"	237	18100	4.64	260	19800	6.1	301	22900	9.4	337	25600	13.1
6 X 9 120"	217	24000	6.2	238	26300	8.06	275	30400	12.49	308	33900	17.4
7 X10½ 140"	185	32200	8.23	204	31500	10.8	235	40500	16.7	264	45400	23.2
8 X 12 160"	163	35500	9.05	179	38900	11.9	207	45000	18.3	232	50100	25.65
9 X 4½	144	45200	11.6	158	49400	15.3	183	57150	23.5	206	63700	32.95
10X5	130	57100	14.6	143	62600	19.2	165	77200	29.0	185	80500	41.4
12x6	109	81300	20.8	119.5	89000	27.2	138	103000	42.0	155	114500	58.8

Size.	1½ Ounces Rev.	Cu. Ft.	H.P.	1¾ Ounces. Rev.	Cu. Ft.	H.P.	2 Ounces. Rev.	Cu. Ft.	H.P.	2½ Ounces. Rev.	Cu. Ft.	H.P.
30"	1350	1580	.974	1460	1710	1.22	1560	1840	1.5	1745	2040	2.1
35"	1240	2110	1.31	1390	2280	1.64	1440	2450	2.01	1610	2720	2.8
40"	1010	2770	1.71	1090	3000	2.15	1170	3210	2.63	1307	3590	3.67
45"	897	3760	2.31	975	4070	2.90	1038	4370	3.56	1161	4870	4.97
50"	808	4520	2.78	874	4870	3.49	935	5230	4.28	1095	5830	5.97
55"	737	5680	3.50	796	6150	4.40	849	6570	5.4	954	7370	7.53
S.P.P.M. 60"	675	6520	4.02	729	7030	5.07	782	7550	6.2	873	8400	8.65
3 X 4½ 60"	675	7840	4.91	729	8460	6.19	782	9080	7.60	873	10100	10.55
3½X5¼ 70"	577	10300	6.35	623	11100	7.98	668	11900	9.78	747	13300	13.7
4 X 6 80"	506	13200	8.12	548	14300	10.2	587	15300	12.5	656	17000	17.5
4½x6¾ 90"	450	18000	11.0	487	19500	13.8	520	20800	17.	582	23300	23.6
5 X 7½ 100"	404	21400	13.12	437	23100	16.5	468	24800	20.2	522	27600	28.2
5½X8¼ 110"	369	28100	17.25	398	30300	21.7	427	32600	26.6	477	36200	37.2
6 X 9 120"	338	37200	22.9	364	40200	28.8	390	43200	35.3	436	48000	49.3
7 X10½ 140"	288	49700	30.6	312	53800	38.6	334	57500	47.3	373	64300	66.0
8 X 12 160"	254	55000	33.7	274	59400	42.4	294	63700	52.0	328	71300	72.6
9 X 4½	225	70200	43.3	243	75900	54.4	260	81100	66.7	291	70800	93.1
10X5	202	88500	54.5	218	95500	68.5	234	102500	84.	261	114000	117.0
12X6	169	126000	77.4	183	136000	97.6	196	146000	119.0	218	162000	166.0

Size.	3 Ounces. Rev.	Cu. Ft.	H.P.	4 Ounces. Rev.	Cu. Ft.	H.P.	5 Ounces. Rev.	Cu. Ft.	H.P.
30"	1910	2240	2.76	2220	2610	4.27	2490	2910	5.97
35"	1765	2980	3.7	2050	3480	5.7	2290	3880	7.98
40"	1440	3960	4.84	1660	4560	7.47	1860	5090	10.5
45"	1280	5370	6.58	1476	6180	10.1	1652	6920	14.1
50"	1150	6450	7.87	1330	7430	12.1	1490	8320	17.0
55"	1050	8120	9.92	1210	9330	15.3	1352	10440	21.4
S.P.P.M. 60"	963	9190	11.4	1110	10700	17.6	1240	12000	24.6
3 X 4½ 60"	963	11100	13.9	1110	12900	21.5	1240	14400	30.2
3½X5¼ 70"	825	14600	18.0	948	16900	27.8	1060	18900	38.9
4 X 6 80"	723	18700	23.0	835	21700	35.5	935	24300	49.8
4½x6¾ 90"	642	25700	31.2	740	29600	48.2	830	33000	67.3
5 X 7½ 100"	578	30500	27.2	664	35200	57.4	744	39200	80.5
5½X8¼ 110"	525	39700	49.0	607	46200	75.6	680	51500	106.
6 X 9 120"	480	53200	65.5	554	61200	101.0	621	68300	141.5
7 X10½ 140"	412	73200	87.0	474	81500	134.0	532	91300	188.0
8 X 12 160"	361	70900	95.6	417	90500	147.5	467	101000	207.
9 X 4½	321	99800	123.0	370	115000	189.0	414	128500	266.
10X5	288	126200	154.0	332	143500	238.0	372	163500	334.
12X6	240	178000	220.0	278	207000	338.0	312	232000	473.

Size.	6 Ounces. Rev.	Cu. Ft.	H.P.	7 Ounces. Rev.	Cu. Ft.	H.P.	8 Ounces. Rev.	Cu. Ft.	H.P.
30"	2720	3260	7.85	2950	3470	9.94	3160	3720	12.2
35"	2510	4270	10.5	2720	4620	13.3	2920	4950	16.3
40"	2042	5600	13.8	2200	6070	17.4	2360	6500	21.3
45"	1816	7620	18.6	1960	8230	23.6	2090	8830	28.3
50"	1636	9140	22.4	1770	9900	28.3	1890	10600	34.7
55"	1490	11500	28.2	1610	12400	35.7	1730	13300	43.7
S.P.P.M. 60"	1362	13200	32.4	1475	14300	41.0	1580	15300	50.2
3 X 4½ 60"	1362	15800	39.6	1475	17200	49.3	1580	18300	60.3
3½X5¼ 70"	1165	20800	51.2	1260	22600	64.8	1350	24200	79.2
4 X 6 80"	1010	26700	65.5	1110	28900	82.8	1190	30900	101.0
4½x6¾ 90"	910	36400	88.8	985	40200	112.0	1050	43000	137.
5 X 7½ 100"	814	43300	106.	878	46800	134.0	947	50200	164
5½X8¼ 110"	742	56800	139.	807	61500	176.0	864	65800	216
6 X 9 120"	682	75300	186	737	81500	236.0	790	87300	288
7 X10½ 140"	513	100300	247	631	109000	313.0	675	117000	383
8 X 12 160"	454	111000	272	555	120500	344.0	594	129000	421
9 X 4½	454	142000	349	492	153000	442.	527	164000	540
10X5	408	179000	440	442	193500	556	473	207000	680
12X6	342	254000	623	370	276000	788	396	295000	965

C. S. Johnson (Thesis)   Table as compiled by B.F. Sturtevant.   Horse Power calculated $\frac{DW}{2}$ Cu. ft. calculated $\frac{DW}{3}$

Blower Number	Wheel		
	Diameter		
	Inlet	Wheel	I
2/0	4 9/16	8 1/4	2
0	5 7/16	9 3/4	3
1	6 1/8	10 7/8	3
2	7	12 1/4	4
3	8 5/8	14 3/4	5
4	10	17 1/2	6
5	11 3/4	20	7
6	14 1/2	23 1/2	8
7	16	27	1
8	18	31	1
9	21	40	1
10	24	46	2
	3 Ounce		
2/0	4200	2	
0	3560	4	
1	3180	5	
2	2840	8	
3	2360	11	
4	1980	16	
5	1740	20	
6	1475	36	
7	1290	52	
8	1120	7	
9	865	117	
10	756	161	
	8 Ounc		
2/0	6380	3	
0	5820	6	
1	5220	9	
2	4640	13	
3	3870	19	
4	3260	21	
5	2850	34	
6	2430	60	
7	2020	86	
8	1860	117	
9	1420	193	
10	1240	265	
	Horse		

C. S. John

Mechanical Engineering Dep't University of Illinois

Table of Speeds, Pressure in Ounces, Capacity in Cubic Feet per min. & Power Required.

Blower Number	Wheel Diameter Inlet	Wheel Diameter Wheel	Width Inlet	Width Outlet	Sq. in. of Blast = DW ÷ 3	Sq. in. of Blast = DW ÷ 2	Circum. of Wheel
2/0	4 9/16	8 1/4	2 9/16	1 1/4	3.44	5.16	2'.16
0	5 7/16	9 3/4	3 3/16	2	6.5	9.75	2'.55
1	6 1/8	10 7/8	3 11/16	2 9/16	9.32	14.0	2'.85
2	7	12 1/4	4 1/2	3 5/16	13.5	20.3	3'.20
3	8 5/8	14 3/4	5 3/8	3 7/8	19.0	28.6	3'.85
4	10	17 1/2	6 1/4	4 1/2	26.3	39.4	4'.57
5	11 3/4	20	7 1/2	5	33.2	50.0	5'.22
6	14 1/2	23 1/2	8 7/8	7 1/2	58.7	88.2	6'.14
7	16	27	11 5/16	9 1/4	83.3	125.	7'.03
8	18	31	14 5/16	11	113.7	170.5	8'.10
9	21	40	16 7/16	14	187.	280.	10'.5
10	24	46	20	16 3/4	257.	386.	12'.0

Blower Number	1/2 Ounce. Rev.	Cu. Ft.	H.P.	1 Ounce. Rev.	Cu. Ft.	H.P.	1 1/2 Ounces. Rev.	Cu. Ft.	H.P.	2 Ounces. Rev.	Cu. Ft.	H.P.	2 1/2 Ounces. Rev.	Cu. Ft.	H.P.
2/0	1695	87.3	.0178	2400	124	.0504	2940	151	.107	3400	175	.143	3800	195	.200
0	1435	165	.0357	2030	234	.0955	2490	286	.171	2880	331	.271	3220	369	.378
1	1285	237	.0484	1820	336	.137	2230	410	.291	2580	475	.389	2880	528	.593
2	1140	343	.070	1620	485	.199	1980	594	.422	2290	688	.564	2560	767	.787
3	950	483	.099	1350	683	.280	1650	835	.595	1910	967	.795	2130	1080	1.11
4	800	667	.136	1130	943	.386	1390	1160	.82	1600	1340	1.10	1790	1490	1.53
5	700	843	.173	994	1190	.490	1220	1460	1.04	1410	1690	1.39	1570	1880	1.94
6	595	1490	.305	842	2110	.865	1030	2580	1.84	1190	2990	2.45	1330	3330	3.42
7	520	2116	.432	736	2990	1.22	902	3670	2.6	1040	4250	3.48	1160	4730	4.85
8	452	2890	.590	640	4080	1.67	884	5000	3.54	907	5810	4.75	1010	6440	6.60
9	348	4750	.97	493	6720	2.74	604	8230	5.82	700	9530	7.78	780	10600	10.9
10	305	6540	1.35	432	9250	3.78	530	11300	8.03	612	13100	10.7	684	14600	15.

Blower Number	3 Ounces. Rev.	Cu. Ft.	H.P.	3 1/2 Ounces. Rev.	Cu. Ft.	H.P.	4 Ounces. Rev.	Cu. Ft.	H.P.	4 1/2 Ounces. Rev.	Cu. Ft.	H.P.
2/0	4200	215	.264	4480	231	.33	4820	250	.407	5070	262	.454
0	3560	407	.498	3790	437	.625	4080	470	.77	4300	495	.861
1	3180	583	.716	3390	627	.897	3660	676	1.10	3840	710	1.24
2	2840	845	1.04	3020	906	1.3	3260	977	1.6	3420	1030	1.78
3	2360	1190	1.46	2510	1280	1.83	2710	1375	2.26	2800	1450	2.53
4	1980	1640	2.02	2110	1770	2.52	2280	1900	3.11	2400	2000	3.48
5	1740	2080	2.56	1850	2230	3.2	2000	2410	3.94	2100	2530	4.42
6	1475	3670	4.5	1570	3940	5.65	1700	4250	6.95	1780	4470	7.80
7	1290	5200	6.4	1380	5600	8.0	1480	6030	9.37	1560	6350	11.0
8	1120	7100	8.72	1200	7620	10.9	1290	8250	13.45	1350	8640	15.
9	865	11700	14.3	920	12600	17.8	995	13500	22.10	1040	14200	24.8
10	756	16100	19.8	806	17300	24.7	870	18600	30.5	912	19600	34.1

Blower Number	5 Ounces. Rev.	Cu. Ft.	H.P.	6 Ounces. Rev.	Cu. Ft.	H.P.	7 Ounces. Rev.	Cu. Ft.	H.P.
2/0	5400	279	.565	5930	306	.75	6440	332	.95
0	4530	527	1.08	5030	580	1.42	5450	626	1.79
1	4190	755	1.55	4500	332	2.04	4880	897	2.58
2	3650	1095	2.24	4000	1200	2.96	4350	1300	3.74
3	3030	1540	3.16	3320	1690	4.17	3620	1830	5.45
4	2560	2130	4.35	2800	2340	5.73	3040	2530	7.25
5	2240	2700	5.53	2450	2970	7.28	2600	3200	9.20
6	1900	4760	9.75	2080	5220	12.8	2260	5650	16.2
7	1660	6750	13.8	1820	7420	18.2	1980	8030	23.0
8	1460	9220	18.8	1600	10120	25.5	1740	10900	31.4
9	1110	15200	31.0	1220	16700	40.8	1320	18000	51.5
10	875	20800	42.7	1065	22900	56.2	1160	24800	71.0

Blower Number	8 Ounces. Rev.	Cu. Ft.	H.P.	9 Ounces. Rev.	Cu. Ft.	H.P.	10 Ounces. Rev.	Cu. Ft.	H.P.	11 Ounces. Rev.	Cu. Ft.	H.P.
2/0	6880	355	1.16	7325	377	1.39	7680	398	163	8100	419	1.88
0	5820	670	2.19	6200	713	2.62	6520	752	3.68	6870	791	3.56
1	5220	960	3.15	5550	1020	3.77	5530	1080	4.43	6140	1130	5.12
2	4640	1390	4.57	4950	1480	5.45	5180	1566	6.42	5470	1640	7.40
3	3870	1960	6.45	4120	2080	7.70	4320	2200	9.04	4550	2310	10.43
4	3260	2170	8.88	3460	2880	10.6	3640	3050	12.45	3830	3200	14.4
5	2850	3440	11.25	3030	3650	13.4	3180	3860	15.8	3360	4050	18.25
6	2430	6050	19.80	2560	6440	23.7	2710	6800	27.9	2860	7140	32.2
7	2020	8600	28.2	2250	9150	33.7	2360	9610	39.5	2490	10130	45.6
8	1860	11720	38.4	1980	12500	46.0	2050	13150	53.8	2160	13800	62.2
9	1420	19300	63.0	1500	20500	75.4	1580	21600	88.5	1670	22800	102.0
10	1240	26500	87.0	1320	28200	104.0	1380	29800	122.0	1460	31300	141.0

Blower Number	12 Ounces Rev.	Cu. Ft.	H.P.	13 Ounces. Rev.	Cu. Ft.	H.P.	14 Ounces. Rev.	Cu. Ft.	H.P.
2/0	8470	437	2.15	8850	458	2.44	9220	475	2.73
0	7180	826	4.07	7500	865	4.60	7820	898	5.15
1	6430	1185	5.83	6710	1240	6.58	7000	1290	7.37
2	5720	1720	8.47	5970	1800	9.55	6220	1860	10.7
3	4760	2420	11.9	4960	2350	13.5	5170	2620	15.1
4	4010	3340	16.4	4180	3500	18.6	4370	3630	20.8
5	3510	4230	20.8	3660	4430	23.6	3820	4600	26.4
6	2990	7450	36.7	3120	7800	41.6	3240	8160	46.6
7	2600	10600	52.1	2720	11100	59.0	2830	11500	65.8
8	2260	14400	71.0	2360	15100	80.2	2460	25800	89.8
9	1740	23800	117.0	1820	24500	132.0	1890	25800	148.0
10	1525	32600	161.0	1530	39200	182.0	1660	35500	204.0

Horse Power Calculated at $\frac{DW}{2}$ Cu. Ft. calculated at $\frac{DW}{3}$ [D = diameter of wheel & W = width at circum.]

C. S. Johnson (Thesis)

Table as compiled by B.F. Sturtevant for "Monogram Blowers"